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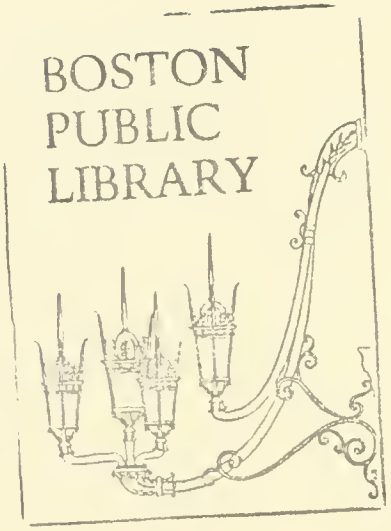
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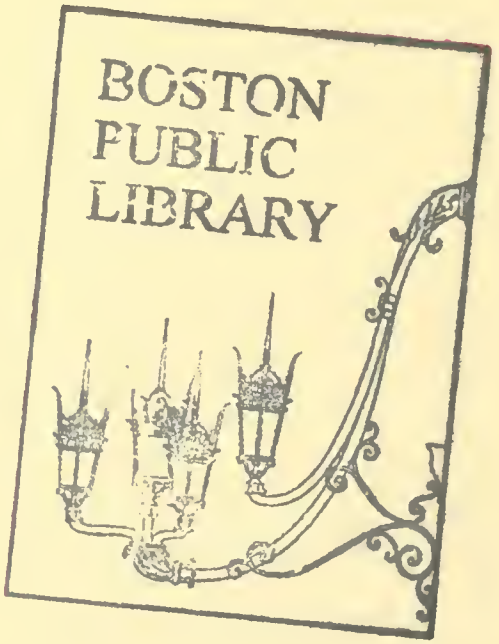
I-93 CENTRAL ARTERY (CONGRESS-NORTH
DESIGN CONTRACT D017A
PRELIMINARY DESIGN REPORT

JANUARY 1991



COMMONWEALTH OF MASSACHUSETTS

CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT

I-93 CENTRAL ARTERY (CONGRESS-NORTH)
DESIGN CONTRACT D017A
PRELIMINARY DESIGN REPORT

JANUARY 1991

PREPARED FOR THE DEPARTMENT OF PUBLIC WORKS
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I-93 CENTRAL ARTERY
CONTRACT D017A
PRELIMINARY DESIGN REPORT

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1.0 General

1.1 Purpose of Report

The purpose of this report is to supplement the Preliminary Design drawings and other documents in order to provide the Section Design Consultant (SDC) with additional information to perform final design. The report also provides background information which would not otherwise be available to the SDC.

1.2 Preliminary Design Drawings

The Preliminary Design drawings for this contract are organized into four major sections consisting of four volumes:

- Volume I - Preliminary Engineering Drawings including General, Survey, Civil, Utilities, Traffic, Architecture (Highways, Vent Building #3, and Landscape) and Right-of-Way.
- Volume II - Structure Design Data Sheets - Tunnels
- Volume III - Structure Design Data Sheets - Vent Building #4
- Volume IV - Structure Design Data Sheets - Underpinning and Temporary Ramps

1.3 Contract Description

Contract D017A is located in the stretch of Central Artery alignment from the existing Dewey Square Tunnel portal to North Street. The approximate station limits are Northbound Station 106+50 at the Dewey Square Tunnel portal, and Northbound Station 141+00 at North Street. The design contract includes all of northbound within these limits. However, the part of the southbound tunnel south of Station 120 (also included in Construction Contract C17A6) is not a part of Contract D017A. From Station 106+50 to this limit at Station 120, the 17A SDC will be responsible for design of the northbound box and both slurry walls.

Design contract D017A also includes the design of Ventilation Building No. 3 located on a parcel east of the main alignment centered at about Northbound Station 110+00. The scope of the design work is described in other contract documents included as part of the preliminary design package. Interfaces with other contracts in progress are described in the following section.

1.4 Interface with Adjacent Design and Construction Contracts

The Downtown D017A contract area abuts several Central Artery/ Tunnel Project design and construction contracts. This section provides a description of these major interfaces tasks.

1.4.1 Area Geotechnical Consultant (Contract G023D)

The scope of work of the Area Geotechnical Consultant (AGC) involves the planning and implementing a field exploration program (borings and test pits), performing laboratory tests, and providing a report that includes recommendations for geotechnical aspects of the design. The AGC's report is expected to include earth pressure diagrams, recommendations for foundation types and other parameters for design, and recommendations to mitigate adverse effects during construction. the AGC will then provide preliminary recommendations for design, which should subsequently be confirmed when the final borings are completed.

The scope of work of the SDC will involve reviewing and using the geotechnical data and recommendations provided by the AGC. The SDC will be expected to evaluate whether the field and laboratory data, and the recommendations provided are sufficient to complete the design. If a need for additional data or recommendations is ascertained, the SDC should then submit a request to B/PB, who will review the request, and then authorize the AGC to perform any additional work that may be necessary. Within the AGC's scope of work, there is time and budget allocated to support the SDC during the design. The role of B/PB, and specifically the B/PB Geotechnical Department, is to assist in managing the work of the AGC and providing coordination between the AGC and the SDC.

Because matters involving scheduling, the field work and the AGC final report for D017A will probably not be available at the NTP date for the SDC. However, there are provisions whereby the AGC will provide preliminary recommendations to the SDC so as not to delay the SDC's work. This will involve bi-weekly coordination meetings between the SDC and the AGC commencing the first week after NTP for the SDC. The SDC should provide guidance to the AGC in terms of prioritizing items for which geotechnical recommendations are needed. The AGC will then provide preliminary and conservative recommendations for design, which should subsequently be confirmed, or made less conservative when the final borings are completed.

1.4.2 I-93 Mechanical/Electrical Systems Contract D020B

The I-93 Mechanical and Electrical Systems Section Design Consultant (D020B) is responsible for the final design of the major mechanical and electrical systems, including the following:

- Tunnel ventilation;
- Tunnel drainage and fire protection;
- Tunnel lighting;
- Exterior roadway lighting; and
- Power distribution.

The preliminary design for D017A includes the requirements for the above systems. A detailed list of the system elements

requiring design coordination and interface between the D017A and D020B SDC's appears on a set of Directive Drawings entitled, Equipment and Final Design and Construction Responsibility Schedules.

Additional information is provided on Mechanical and Electrical Standard and Directive Drawings. All preliminary information related to these systems is subject to final verification by the D020B SDC.

During the course of final design, D020B will provide D017A with the following information:

- Final verification of sizes, quantities, and locations for all embedded items (e.g., electrical conduits, pull-boxes, drainage piping, etc.).

- Final dimensions, arrangements, and routing for all tunnel ventilation system air ducts.

- Final equipment arrangement, sizes and weights for Ventilation Building No. 3.

Refer to Chapters 10.0 and 11.0 for further descriptions of the major mechanical and electrical systems and the interfaces required.

1.4.3 Integrated Project Controls System (D022A)

The Integrated Project Controls System Section Design Consultant, Design contract D022A, will develop the final design documents for the integrated project control system which include communications and control equipment, incident detection and alarm systems, closed circuit television systems, signing and metering for roadway traffic. The associated construction contract will be C22A2.

The overall system, as planned, will be integrated, with thousands of signals that will be transported over fiber optic links between centralized information display/decision/control points and a distributed network of many intelligent multipurpose Remote Terminal Units (RTUs). Visual support in the form of Closed Circuit Television (CCTV) as well as associated telephone and radio voice communications systems are also planned. The Integrated Project Control System will support all administrative maintenance, tactical and emergency responses.

1.4.4 Right-of-Way Assessment and Remediation (Contract M025A)

The Right-of-Way Assessment and Remediation Services (ROWARS) consultant, contract M025A, will conduct environmental assessments of all parcels and buildings to be acquired to build and operate the project, characterize the nature and extent of

any hazardous materials or hazardous release within the parcels and buildings and design any required remediation of the hazardous materials or release.

Remediation of sites will be carried out by either a separate remediation contractor prior to construction in that parcel or prior to demolition or use of a building, or plans and specifications will be provided to the SDC to incorporate into the 100% design package(s). Technical review and oversight of the remediation will be through the Management Consultant as assigned by the Department.

The ROWARS Consultant will prepare the following documents:

Initial Assessment Report,
Characterization Report,
Clearance Plan (as needed),
PS&E for each area to be remediated (as needed).

Should the ROWARS consultant define nonhazardous conditions which require special handling for the purposes of materials disposal and/or protection of construction personnel the ROWARS consultant will provide plans and/or specifications to be included in the SDC 100% design package(s).

It will be the responsibility of the D017A SDC to work with the ROWARS consultant to obtain all pertinent information for the D017A Contract Area.

1.4.5 Early Utility Relocations (Contract D014B & D014C)

Contract D014C utility relocations Congress to North is the utility contract preceding D017A. It includes two categories of relocations: major utilities and minor utilities. The relocated facilities are to be placed in permanent corridors, crossing the tunnel alignment. All major utilities, with the exception of those services indicated in the preliminary design package, will be relocated prior to tunnel construction. Note that some longitudinal relocated utilities are to be placed in the area directly above the future tunnels, and will require support during construction of the tunnel sections.

With the exception of gravity sewers and major utilities all others will generally be below existing lines.

In addition to the relocation of major utilities, there are several minor utilities which the D014C SDC will consider. These may include Western Union, fuel oil and brine in addition to roadway oriented facilities such as lighting, traffic signal, police signal, fire signal and drainage, and other facilities that may be in conflict with the construction of relocated major utilities. Design contract D014C will involve only relocations (temporary or permanent) of these existing facilities made necessary by the relocations of the major utilities.

The relocation design of minor utilities that may be in conflict with the construction of the cut-and-cover tunnel will be the responsibility of the D017A SDC.

Contract D014B utility relocations North to Causeway is the adjoining utility contract North of the D017A contract area. It interfaces directly with design contract D015A Central Artery North to Causeway. It has the same design considerations as D014B.

1.4.6 Final Surface Restoration D015C

Contract D015C is the Final Surface restoration contract. Design of the final surface street alignment and interim planting is included in package, D017A. The D015C SDC will be responsible for the final surface preparation of roadways, sidewalks as well as landscaped parcels.

It will be the responsibility of the D017A SDC to provide the D015C SDC with the necessary information relative to final alignment and site specific details upon completion of D017A.

1.4.7 I-93 North To Causeway (Contract D015A)

This important interface contract includes design of the Central Artery tunnels and transition sections from approximately Station 141+00 Northbound to Station 168+50 Northbound. D015A also includes design of ramp connections to the Sumner and Callahan tunnels, and design of Vent Building 4. The D017A SDC will be expected to work closely with the D015A designer to help coordinate final design of the various tunnel components.

1.4.8 Blue Line Crossing (Contract D017B)

Design Contract D017B includes design of a portion of the mainline tunnel from approximately Station 130+35 to Station 131+85 Northbound. This is the portion of the alignment where the depressed artery tunnel crosses the MBTA Blue Line. The D017B SDC will design a structure that is incorporated in the planned extension of the Blue Line Aquarium Station.

Note that the D017B SDC will only design the tunnel box structure. The D017A SDC will design all highway items that fit within the tunnel, such as tiling, pavement, suspended ceiling, roadway striping, lighting and other items.

1.4.9 I-93 Congress to Kneeland Contract (D011A)

Design Contract D011A is one of two highway tunnel contracts directly to the south of D017A. These contracts share a contract limit at approximately station 106+70, the portal of the existing Dewey Square Tunnel. This contract includes design of the Central Artery northbound lanes in a cut-and-cover tunnel beneath Atlantic Avenue. The D011A SDC will be required to design a complex underpinning structure to permit the tunnel to pass beneath the MBTA Red Line at Summer Street.

Much of what is designed under D011A will directly effect the D017A SDC. Horizontal and vertical design will need to be coordinated on a regular basis to insure a uniform design at this interface point

1.4.10 Dewey Square Tunnel Reconstruction (D018A)

Design Contract D018A forms the second tunnel design contract at the southern limits of D017A. This package includes design of improvements to the existing Dewey Square Tunnel. At this time, it is not yet decided which contract the section of new tunnel from Station 106+50 to Station 120+00 will be included in. This segment may be a part of contract D018A, it may be included in D017A, or it will be placed in a separate contract. The D017A SDC will need to work closely with the designer of this additional segment of tunnel, regardless of which design contract it is included in.

1.5 Project Design Criteria

The purpose of the Project Design Criteria is to establish uniform design criteria for the Central Artery (I-93)/Tunnel (I-90) project. The criteria are intended for use by all parties involved in the product design, referred to as designees, including the personnel of the Management Consultant performing the preliminary design and the Section design Consultants and their subconsultants performing the final design.

The Project Design Criteria will be provided to the SDC at the time of Notice of Proceed (NTP). The SDC shall adhere and conform to the criteria as discussed in the following sections.

Section I - Introduction

Purpose and general organization of the criteria.

Section II - Basic Policies

Basic policies governing the use of criteria.

Section III - Civil

Design criteria for geometric controls, clearance requirements, drainage, and other elements of design for highways and city streets.

Section IV - Utilities

Design criteria for the relocation, support or maintenance of existing utilities that will be affected by the project construction and for the installation of new utilities.

Section V - Structural

Design criteria for structures, including bridges, retaining walls, cut-and-cover structures, immersed tubes, above-ground structures, temporary construction structures and other miscellaneous structures.

Section VI - Architectural

Design criteria for the architectural treatment of bridges, tunnels, transition sections, at-grade roadways, toll plaza, ancillary buildings and noise barriers, and for landscaping.

Section VII - Mechanical

Design criteria for mechanical systems, including the tunnel ventilation, tunnel drainage, plumbing, fire protection, and ancillary facilities heating, ventilating and air-conditioning systems.

Section VIII - Electrical

Design criteria for electrical systems, including the primary distribution, secondary distribution, standby power, grounding and lighting protection, building lighting, tunnel lighting, exterior roadway lighting, tunnel raceway and underground raceway systems.

Section IX - Traffic Surveillance and Control

Design criteria for signage and for the traffic surveillance and control system.

2.0 Survey

The project mapping was prepared from aerial photography flown on August 2, 1987. The photographs were taken at an altitude to support 1 inch equals 20 feet (20 scale) mapping. Primary control was installed by the Global Positioning System (GPS) on an XYZ rectangular coordinate system and is a first order-class 1 survey.

Applicable survey information for the D017A contract is shown on the survey control sheets which are included in the preliminary design package.

3.0 Geotechnical

3.1 Existing Data and Planned Exploration

As shown on Drawing Nos. PW-PD-K-081 and PW-PD-K-082, Boring Location Plan, there is a considerable number of previously drilled borings in the Central Artery corridor.

Subsurface profiles along the proposed slurry walls are shown on Drawing Nos. PW-PD-K-083 through PW-PD-K-086. Most of the borings shown on the Boring Location Plan were drilled as part of the exploratory program for the original Central Artery construction. A few are from more recent explorations performed under the technical supervision of Bechtel/Parsons Brinckerhoff. Boring logs showing the existing data are compiled in the "Geotechnical Report, Existing Subsurface Data, Central Artery - South of Causeway." Copies of these documents will be available to the SDC for information. Copies of the logs of borings shown on Drawings PW-PD-K-081 and PW-PD-K-082, Boring Location Plans, are included in Appendix C.

It is difficult to ascertain the relative accuracy and reliability of the various sources of the existing data. Therefore, the soil profiles shown in the preliminary design drawings may not accurately represent soil conditions at all locations, and particularly at locations where the data are interpolated between borings.

In general, it is concluded that sufficient geotechnical information exists for the purposes of preliminary design. There are Standard Penetration Test (SPT) data in all strata, which allows preliminary analysis of the various subsurface soils with regard to stiffness or density, bearing characteristics, and expected vertical and lateral earth pressures.

An extensive program of exploratory borings and test pits will be conducted within the next few months by the Area Geotechnical Consultant (AGC). Approximately 90 borings specifically related to the D017A Design contract are planned. Forty-nine additional borings are proposed along the route of the slurry walls and utility relocations for the D014C Design Contract. This investigation program includes borings in areas where insufficient subsurface information is currently available (Central and State Street).

3.2 General Subsurface Conditions

The subsurface conditions along the project location, as shown in Drawings Nos. PW-PD-K-83 through PW-PD-K-86, are highly variable. In general, between NB/SB Stations 120 and 140 the subsurface conditions are similar along both the East and West slurry walls. [Note: The stationing along the east slurry wall (NB) and the west slurry wall (SB) differ slightly, but are

approximately equal. For convenience, they are collectively referred to as the NB/SB stationing.] Between NB/SB Stations 105 and 120, the profile along the East slurry wall differs from the West slurry wall in that the till is encountered at greater depths along the East slurry wall. There are also thicker deposits of organic silt and glacio-marine soils along the East slurry wall between NB/SB Stations 105ê and 120ê. In general, the subsurface profile along the East and West slurry walls for this contract consists of the following strata:

Fill - consisting primarily of sand and gravel, along with cobbles, brick, concrete, wood and other miscellaneous materials. The fill stratum is usually found directly below the pavement or concrete areas, and extends to a depth of 3 to 20 feet below the ground surface.

Organic Silt - consisting primarily of soft silt and shells. The organic silt is present between NB/SB Stations 125± and 138± along the West slurry wall. It is also present between NB/SB Stations 105± and 110±, and between NB/SB Stations 123± and 140± along the East slurry wall. The thickness along the East slurry wall varies greatly from 1 to 23 feet, being thicker between NB/SB Stations 123± and 140±. There are also pockets of the organic silt along the Eastbound slurry wall (1 to 7 feet thick) at NB/SB Stations 112± and 120+50±.

Silty Clay - The silty clay stratum is usually stiff to hard near the top of the stratum, but becomes medium stiff to soft with depth. In areas where there is an organic silt stratum, silty clay or glacio-marine layers underlie the organic silt. Where the organic silt stratum is absent, the silty clay stratum is up to 85 feet thick, and it is found towards the northern end of the contract limits (NB/SB Stations 130± to 140±).

Glacio-Marine Deposit - There are two major deposits of glacio-marine soils. The first is between NB/SB Stations 116± and 125±. This deposit is underneath the fill. The second deposit is located between NB/SB Stations 131± and 138±, and underlies the clay stratum. The glacio-marine deposits consist of a mixture of silty clay, sand, gravel, and cobbles. The glacio-marine deposit is relatively stiff or dense.

Silty Fine Sand - Within the contract limits a pocket of fine sand has been encountered. It is beneath the clay stratum and is loose to medium dense. The thickness of this pocket ranges from 1 to 13 feet between NB/SB Stations 130± and 132±.

Glacial Till - consisting of a mixture of sand, gravel, silt, and clay, this stratum exists immediately above the bedrock at practically all locations. The thickness of this stratum varies greatly from 0 to 120 feet. The top of the stratum usually occurs at a depth of 5 to 40 feet. The till is encountered at lesser depths (5 to 15 feet) along the West slurry wall, and is encountered at greater depths along the East slurry wall.

Bedrock - consisting of the Cambridge Argillite. The top of rock occurs typically at depths of 70 to 130 feet. The rock is variably weathered and fractured.

Groundwater is usually encountered within the fill at depths of 5 to 15 feet below the ground surface. However, there is evidence that groundwater wells installed with screens in the till or rock may indicate readings below the hydrostatic levels encountered in the fill.

3.3 Geotechnical Design Elements

The proposed tunnel structures and boat sections, which are part of the D017A Design Contract, consist of reinforced concrete sections that will be constructed using the cut-and-cover method. To perform the excavations, it is anticipated that the temporary excavation support will consist of concrete diaphragm walls constructed by the slurry trench method or by the soldier pile tremie concrete (SPTC) method. The temporary excavation support walls are intended to eventually be structurally integrated into the walls of the permanent structure.

The design of the excavation support and permanent structural walls of the tunnel will require consideration of bearing pressures, lateral earth pressures, pore water pressures, and other lateral loads such as those due to traffic, construction equipment, and earthquakes. The walls will have to be designed to support vertical loads due to the weight of the permanent tunnel structure and backfill on top of the tunnel. In most sections, there will also be vertical loads due to the street level traffic decking and underpinning of the existing overhead Central Artery structure. The street level decking and underpinning of the existing structure are required to maintain traffic flow during construction.

Another geotechnical design consideration is the need to resist uplift forces due to hydrostatic water pressures acting on the bottom slab of the tunnels. These uplift pressures will be especially problematic at boat sections and in the relatively deep structure at Vent Building No. 3. At these locations, resisting the uplift load will require the design of either a gravity slab, concrete hold down elements, tie-down anchors, or a combination of these systems.

The design of the bottom slabs of the tunnels will require consideration of the modulus of subgrade reaction and soil structure interaction. Differential movements which may result from varying soil support conditions at the base of the tunnel will also require consideration. While hydrostatic pressures may not cause a net uplift force in most of the tunnel sections, they will nevertheless create a loading that will tend to increase the moments in the base slab of the tunnels.

The protection of adjacent buildings during construction is an important design consideration. The diaphragm walls should be designed to provide adequate stiffness and lateral support to limit deformations of adjacent structures. In some cases, it may be necessary to underpin existing buildings to prevent potential damage that may otherwise result during excavation.

During construction, it will be necessary to dewater the excavation, and at the same time to maintain the existing ground water levels outside the excavation. The requirement for maintaining existing ground water conditions is related to the protection of old buildings founded on wooden piles, which may deteriorate due to extended exposure to air resulting from ground water lowering. The design of the excavation should also consider problems of bottom in stability that may result from dewatering.

There are several interfaces with other contracts which should be considered. These include the D014C Utilities Relocation Design Contract, and the D017B Blue Line Crossing Design Contract. At the D014C interfaces, the concrete diaphragm walls related to this design contract will be constructed before the walls for the D017A Design Contract. The D017B Blue Line Crossing Design Contract involves the extension of the Aquarium subway stop platform. Prior to construction of the Central Artery the Aquarium Station is scheduled to undergo major improvements that include extending the existing train platform. At the time of the Aquarium Station construction, slurry walls would be installed and a portion of the Central Artery tunnel boxes would be constructed above the Blue Line. In addition, it is important to consider the sequence of construction within the D017A Design Contract and the limitations imposed by the sequence on the design of the structures.

Geotechnical recommendations to be used for the final design of the tunnel structures and boat sections will be provided by GEI Consultants, the Area Geotechnical Consultant primarily responsible for the D017A Design Section.

4.0 Civil Design

4.1 General

The purpose of the Civil Design Section is to describe the factors which govern the civil design of D017A. Contract D017A meets contract D015A to the north approximately at the portal of Ramp CS-SA at Station 141+00. The southern limits of D017A are Station 120+00 on I-93 southbound and 107+00 I-93 northbound. The D017A contract is interrupted between Stations 130+55 and 131+85 by the D017B contract. The D017B contract involves the interface between the proposed Central Artery and the MBTA Blue Line Aquarium Station extension project. Ramps included in the D017A contract are CN-SA, CS-P, R-T, and A-CN. Also included in the contract is the surface street system within the contract limits, a temporary ramp and a temporary bridge, three pump stations (to drain water from the portals), emergency egress stairwells, and other incidentals necessary for the completion of the contract.

4.2 Design Criteria

The Project Design Criteria establishes uniform design standards for the Central Artery (I-93)/Tunnel (I-90) Project, and are intended for use by all parties involved in the project design. The project shall be designed in accordance with the applicable provisions of these criteria. The civil section establishes the basic design criteria for geometric controls, clearance requirements, drainage, and surface streets constructed as part of the Central Artery project. The design criteria specify that design shall meet the minimum design standards of AASHTO, MDPW, City of Boston, or other selected government agencies or professional organizations. Any exceptions to the design criteria must be submitted to the MDPW and the FHWA for approval.

Aligning the Central Artery through downtown Boston proved to be extremely challenging. The necessity of maintaining existing structures and the close proximity of their foundations imposed numerous design constraints. In all possible cases the project design criteria were met. In other cases, a balance of design considerations was attempted in order to rationally apportion deviations and exceptions. The Project Design Criteria cites AASHTO, MDPW, and City of Boston standards. This report cites the design considerations encountered while attempting to adhere to those standards.

4.3 Project Datum

Horizontal control for roadway alignments is based on survey control points established and referenced to the Massachusetts State Plane Coordinate System, Mainline Zone, and North American Datum, 1983 (NAD 83). Vertical control is based on the National Geodetic Vertical Datum of 1929 (NGVD 1929), formerly US Coast

and Geodetic Survey Mean Sea Level Datum of 1929. The project datum plane is established at 100.00 feet below NGVD 1929.

4.4 Design Description

In the northern portion of the D017A contract the I-93 profile is steep in order to clear the Blue Line. The proposed Central Artery will cross the MBTA Blue Line tunnel at State Street immediately west of the Aquarium Station. The Blue Line runs directly under State Street and is perpendicular to the Central Artery alignment. The MBTA has proposed to extend the Aquarium station platform to accommodate six and, in the future, eight cars. This project is scheduled to go to construction before the Central Artery.

Due to the fact that much of the proposed construction in this area is common to both the MBTA and MDPW (walls, roof/floor, excavation, utility relocation, etc.) and in order to have minimal disruption, close coordination between the two projects is required. The restricted ceiling height of the station tunnel, due to the Central Artery depression, has resulted in a unique structural design of a composite Blue Line tunnel ceiling slab designed to accommodate the proposed Central Artery floor slab, thereby reducing the overall slab depth (and subsequently lessening the grade of the I-93 profile) that might otherwise result from two separate and independent designs. The MBTA also will construct the Central Artery roof and outside walls, effectively leaving an empty "box" for the artery to tie into. Some utility relocation in the area is under the D017A contract.

South of the Blue Line, I-93 descends to get beneath two 66" gravity flow storm drains near station 125+00 +/-. The D017A contract limit for I-93 southbound is station 120+00. I-93 northbound continues to descend to go under the Red Line at South Station. The contract limit for the northbound mainline is 106+70.

Ramp CN-SA exits I-93 northbound just south of the Blue Line and meets the surface near the Callahan tunnel. In front of the Mercantile Wharf buildings two lanes of surface traffic are required. The boat section of Ramp CN-SA is proposed as far west as possible, allowing for these two surface lanes. Ramp CN-SA shares a wall with I-93 northbound, and I-93 northbound and southbound have a common center wall, thus this constraint is reflected across the alignment in this area. Because some of the walls (as well as some roof/floor slabs) between the ramps and mainlines are common, many of the constraints have a ripple effect throughout the alignment. There are similar situations in the D017A contract near Marketplace Center, New England Telephone building, the Harbor Towers Garage, 200 High Street, and the Rowes Wharf Garage where due to constraints and common walls the geometry of ramps and mainlines are closely related.

Ramp CS-P exits I-93 southbound just south of the Blue Line and

climbs to meet existing grade at Oliver Street. The D017A contract limit for this ramp is approximately station 120+00. Near the portal of the ramp it crosses onto the top of the I-93 southbound tunnel box. There is a critical clearance point at approximately station 121+75 +/- where this crossing takes place.

Ramp R-T originates near Dewey Square and the portion of the ramp from Station 120+00 (I/93-SB) north is included in the D017A contract. Ramp R-T merges with A-CN and continues north forming a left hand entrance to I-93 northbound at State Street.

4.4.1 Transition Curves, Superelevation, and Cross Slope

The central curve to the left on the mainline between stations 112 and 120 has an 800' radius. This curve requires an 8% rate of superelevation. Two curves of 4200' radius and 1800' radius transition this central curve to and from the tangent (3300' radius and 1850' radius entering the 800' radius CASB curve). Another similar situation exists, between station 132 and station 136, with central curve radii of 950' CANB and 920' CASB, requiring a superelevation of 6%. The transition curve radii differ for these, however. The interfaces with D011A and D015A are on tangent sections.

The transition lengths for the 800' radius curves allow transition from the normal 2% to the full 8% superelevation. The transition lengths for the 950' and 920' radii curves allow transition from 2% to 6%. This transition ends in D015A, where a 6% cross slope is required in the opposite direction.

The Central Artery ramps transition from 2% cross slope at the mainline to a maximum of 6% or 8% where the radii dictate. Due to the location of existing structures to remain and the lower design speed of the ramps, transition curves have not been used for all cases.

4.4.2 Sight Shelves

Horizontal stopping sight distance is limited by right of way constraints that require small radius curves and also limit the distance the walls can be pushed back from the traveled way to provide clear sight lines. An object higher than 8 to 9 inches encroaches on the line of sight from the driver's eye to a 6 inch object in the center of the lane. Sight distance, then, is measured to the face of the safety walk and not to the face of the wall.

Areas of curves where the radii are short require widening the pavement on the inside edge to allow for adequate horizontal sight distance. This widened pavement is called a sight shelf, and its design is based on the radius and sight distance.

The minimum required width of the sight shelf is given by the

formula M = R[1-cos(28.65s/R)], or 17.7' for the 800' radius 50 miles per hour northbound mainline curve (R = 807', s = 400'). The value for m = 24.7'; therefore, the sight shelf equals 24.7' less 6' half lane width, less 1' shoulder = 17.7'. The 800' radius CASB curve requires a 19.3' wide sight shelf. The 950' and 920' curves require 13.8' and 15.7' wide sight shelves.

Ramp sight shelf requirements vary from 4.0' to 13.0' in width, as follows. Ramp RT requires a 13.0' shelf, Ramp A-CN a 10.3' shelf. None is provided, however, due to the horizontal constraints imposed by One International Place and Phase II Tower. When they merge as Ramp ACN-RT the mainline requirements govern and dictate a 13.8' shelf. Likewise Ramp RR is governed by the mainline requirement for a 19.3' shelf. Ramp CS-P curve needs a 11.5' shelf. It also, however, is constricted by One International Place and Phase II Tower. Ramp CN-SA requires a 4.0' sight shelf.

4.4.3 Entrance and Exit Gores

The standard entrance and exit ramp details allow smooth transition from a ramp onto the mainline and vice versa. Detail sheet No. CA-PD-C-624 provides the length of taper necessary to properly merge a ramp with the Central Artery mainlines based on the width of the nose. The details also allow a safe refuge and decision area at exit ramps, while providing room for an impact attenuator.

Ramp ACN-RT is a special case as it merges with CANB from the left. It tapers from 20' at the nose to 14' in approximately 280'. Ramp SA-CS tapers from the nose at station 141+25 to 12' in 200'. This reduction in taper length is the result of concerns for right of way and geometry.

Exit Ramps CN-SA, CS-P, and RR have more than adequate offset at the gore. Twelve feet are required from the lane edge to the extended edge of the safety walk, and 16' are provided. This may easily be refined during final design.

4.4.4 Vertical Alignment and Clearance

Throughout the alignment, ramp and mainline structures share roof slabs, floor slabs, and walls. Vents are in the ceiling and floor for the most part. An exception is Ramp CS-P where the exhaust vent is in the wall. These vents are interrupted by utility corridors and the Blue Line crossing. Any horizontal design modification invariably affects the vertical alignments, and vice versa. Also, ramp grades approach or reach the maximum allowable of 7%, with few exceptions. In all cases the vertical clearance of 17' is met, except for ramp RT, which allows a 14.5' clearance.

4.5 Construction Staging and Traffic Management

The maintenance of safe, efficient vehicular and pedestrian traffic flows during construction is a sensitive issue which must be coordinated between all interfacing construction contracts. Maintenance of traffic plans must consider all the contractors, subcontractors and public agencies involved as well as provide pedestrian access to adjacent properties.

The method of wall construction selected for the majority of the tunnel construction is slurry walls using soldier piles and tremie concrete (SPTC walls). Some sections will allow the use of steel sheet piling; however, this will generally only occur where the tunnel lies close to the surface or the proposed structure is a boat section or depressed roadway. Slurry wall (SPTC) construction will be accomplished in varying lengths of up to 20 feet long, alternating along each side of the alignment. Early emphasis will be placed on construction of the east side slurry wall, to provide for the construction of the CANB tunnel and northbound ramps. Following construction of the slurry wall, intermediate supports (drilled caissons) will be installed, thus providing support for the deck beams and decking which span between the slurry walls and drilled caissons. Upon completion of the decking operation, the contractor will begin excavation, intermediate cross bracing installation, and tunnel construction.

4.6 Design Exceptions

The D017A contract area through downtown Boston is extremely congested. The sensitivity of the area along with the close proximity of existing structures have allowed only a narrow corridor for the design and has resulted in the necessary design exceptions.

Design exceptions have been identified for the following roadway features: shoulder width, sight distance, transition curves, radius, superelevation, and ramp details.

4.6.1 Shoulder Width

Highway cross sections in the Project Design Criteria for the Central Artery include provisions for shoulder widths of 4' on the left and 10' on the right. Severe right of way restrictions require that the tunnel cross section width be reduced to a minimum. The typical sections and details carry an allowance for 1' shoulders on the left and right.

4.6.2 Sight Distance

Sight shelf requirements for sight distance considerations vary from 13.8' and 19.3' for the Central Artery and 4.0' to 13.0' for the ramps. Due to horizontal constrictions, a maximum 12' sight shelf is provided in any case. This will be constructed of a textured pavement of a color different than that for the traveled way.

4.6.3 Transition Curves

Project Design Criteria requires that any curve with R < 3,300 feet must be transitioned with compound curves in succession at Rn+1 = 1.5 Rn. In 1984 AASHTO no specific criteria are provided. Right of way constraints limit the space available for transition curves while requiring small radius curves.

The primary purpose of transition curves is to ease the driver into relatively sharp central curves, providing an alignment that allows most drivers to negotiate the tangent to curve shift without straying out of their lane and while maintaining a constant speed.

Transition curves also provide a convenient place to runoff superelevation. Calculations show that 300 feet is a reasonable distance to runoff the superelevation for the curves on this alignment.

4.6.4 Radius

Minimum radius for 50 miles per hour design according to the Project Design Criteria equals 850 feet using a 6% maximum superelevation rate. A radius of 800' was selected in order to alleviate constraints to the alignment.

4.6.5 Superelevation

The primary reason for limiting cross slope to 6% is for safety in snow and ice conditions. In the Central Artery tunnels, snow and ice will not be factors, and cross slope can reasonably be increased to 8% to accommodate right of way constraints. 50 miles per hour design can thus be maintained using an 800 foot radius curve.

4.6.6 Ramp Details

The Entrance and Exit Ramp Details call for a length of taper for merging and diverging ramps meeting certain length requirements based on the width at the nose. Again due to right of way constraints, some tapers were shortened in order to reduce the impact to adjacent structures.

5.0 Structural Design

This chapter includes four sections:

- 5.1 Tunnel Design
- 5.2 Boat Section Design
- 5.3 Design of Vent Building 3
- 5.4 Design of Artery Viaduct Underpinning

5.1 Tunnel Design

Plan, layout, sections and profiles of Central Artery tunnels are shown in various documents which comprise the preliminary design package.

In this section, elements of the tunnel design are reviewed.

5.1.1 Tunnel Design- General

Central Artery tunnels will feature the following type of construction:

- Tunnels will be built by the cut-and-cover method.
- To support the excavation, three rigid cofferdam walls will be built.
- Cofferdam walls are integrated in the final structure.
- Cofferdam walls will be largely of soldier pile tremie concrete (SPTC) construction.
- Mainline roof members will be largely of steel beam and concrete slab composite construction.
- Base slabs will be constructed of reinforced concrete.
- Interior ramp walls and some roof members will be constructed of cast-in-place concrete.

Design loadings, load combinations, code specifications, and other criteria are discussed in the Project Structural Design Criteria.

5.1.2 Soldier Pile Tremie Concrete (SPTC) Walls

Cofferdam walls will feature soldier pile tremie concrete construction. The soldier piles will be spaced from 4' to 6', with wider spacing in special locations determined by final design.

5.1.3 Roof Slabs

Roof slabs will be built using steel girder concrete composite

construction. The steel girders will be spaced to match the layout of the soldier piles in the slurry walls. The concrete roof slab will be compositely connected to the girders by shear studs. The roof girders will be rolled sections or built-up girders depending on the final design. Preliminary design of the roof girders assumes a pinned connection to both SPTC walls and cast-in-place walls. The final design may find some advantage in detailing fixed connections at some locations. Where permitted by the vertical layout, the final design should consider some roof beams to run continuously across cast-in-place walls.

5.1.4 Base Slabs

Base slabs will feature cast-in-place construction. Preliminary design layout has used, for analysis, only the portion of the base slab below supply vents. The final design should consider the advantages of a Vierendeel framing model, or another appropriate model, to take advantage of structural action of the roadway slab.

Preliminary design of connection of base slabs to walls have been treated as fixed. One possible detail to achieve this connection requirement is shown in the preliminary design package.

5.1.5 Other Structural Elements

a. Excavation Support

Excavation support is envisioned to be cross-lot bracing. Pin piles may be needed to help support cross-lot bracing for wider cuts between cofferdam walls. The design may be able to take advantage of tie-backs in some areas.

b. Interface With Underpinning Support

Refer to Section 5.4 of this chapter for additional information about design of underpinning for the existing Central Artery viaduct bents. Note that the underpinning will be largely supported by cofferdam walls. The final design will include details to ensure that underpinning loads are transferred adequately in the longitudinal direction so that cofferdam wall base bearing pressures will be acceptable.

c. Tunnel Cross Passages and Utility Rooms

Preliminary design includes layout of cross passages spaced at approximately every 300' along the alignment. Some of the cross passages and emergency egress/access passages include small tunnels, which will be built of reinforced concrete. Cross passages are placed between soldier piles where they penetrate cofferdam walls.

Note that some emergency egress/access passages are placed outside the alignment of the cofferdam walls. For excavation and construction of these structures, the final design should consider the possibility of moving the cofferdam walls to the outside of the egress/access plenums. This decision should be based on construction

considerations (particularly, position of nearby existing structures) and final geotechnical information, to be provided by the AGC.

Pump Stations are located as indicated in the preliminary design documents.

d. Interface with Vent Building 3

Lateral vents connect the mainline and ramp tunnels centered at approximately Station 110 Northbound. The final design of the structural sections at this location will need to take into account the position of these vents and the changing support and framing conditions that they impose on the tunnel boxes.

e. Waterproofing

Waterproofing concepts are reviewed in a separate report. Waterproofing is of additional concern for Central Artery tunnels because the cofferdam walls are integrated with the final structure. The final design must provide for watertightness at the connections of the roof to cofferdam walls, and base slab to cofferdam walls.

f. Interface Issues

As shown in the Preliminary Design Drawings, the portion of tunnel from Station 106+70 to Station 120+00, Southbound and ramps, is not included in design package D017A. The SDC will need to coordinate design activities with the final designer for that portion of the tunnel.

Note that the preliminary design includes space for a proposed MBTA transitway box above the northbound mainline tunnel. The final design of the tunnel will need to incorporate transit tunnel loads, space requirements, a crossing of the cofferdam wall north of Vent Building 3, and other design interface issues. The tunnel preliminary design uses soil loads in the space reserved for the transitway for the purpose of preliminary sizing of tunnel structural elements.

5.2 Boat Section Design

Design contract D017A features exit and entrance ramp boat sections which are mostly part of the overall tunnel frame structure. They are positioned alongside or above mainline tunnel boxes. They should be designed as part of the overall tunnel framing structure.

5.3 Design of Vent Building 3

This section describes the structural type selected for ventilation Building No. 3, which is part of Design Contract D017A.

5.3.1 Design of Vent Building 3- General

A detailed analysis was made of the building configuration

considering its location. The building site, the Boston Edison Company (BECO) Substation #3 parking area, can be described as follows:

- The East wall of the structure is adjacent to the BECO transformers platform.

- The Northwest corner of the building, adjacent to Atlantic Avenue, is truncated at sub-level 1 to provide space for the future MBTA underground transit way (by others).

- The South and North limits of the building are adjacent to the Russia Wharf building and Harbor Plaza building respectively, set back to allow BECO utility corridors, which will be utilized for the relocation of the electrical cables now running within the proposed building site.

Based on the depth of the CA Tunnel (approximately 90 feet under grade level), the depth of the building foundation/substructure became one of the principal type study issues due to hydrostatic uplift pressure, the water table being approximately 8 ft to 10 ft below grade level. Other concerns included the overall building configuration and mechanical requirements, which helped determine column grid lines. This became the basis for selecting a typical structural framing bay for which alternative structural systems were designed for the floor slabs. Refer to the Structural Type Study, Vent Building #3, for additional information about development of the structural scheme for the building.

5.3.2 Design of Vent Building #3- Structural Recommendations

The comparative technical/cost analysis for the building primary structural components results in the following recommendations:

- Building Foundation/Substructure:
  Foundation- Reinforced concrete mat
  Perimeter Walls- Reinforced concrete or soldier pile tremie concrete slurry walls (as determined), in part by the adjacent tunnel structure) structurally integrated with other building substructure components as part of the permanent structure.

- Building Structural Frame:
  Reinforced Concrete Beams, Columns & Girders.

- Building Floor Slabs:
  15"(+_/-) thick reinforced concrete slab supported by concrete beams and girders (Alternative I).

- Exhaust Stacks:
  Reinforced concrete walls structurally integrated with other building superstructure and substructure components.

5.4 Design of Artery Viaduct Underpinning

This section describes the Underpinning of the elevated structure during the construction of the subsurface Artery which is part of Design contract D017A.

5.4.1 Scope

Traffic will be maintained on the existing elevated Artery Viaduct between Bent 1 and 67 during construction of the new subsurface Artery. Traffic will then be diverted to the new subsurface Artery prior to the demolition of the elevated structure. In order to construct the subsurface Artery which is below the existing elevated structure, it will be necessary to underpin the elevated roadway.

5.4.2 Method

In general, the Underpinning system will consist of needle beams bracketed to the existing elevated structure columns which in turn will be supported on grade beams. The grade beams will generally be installed just below grade to allow for the installation of a decking system and in turn supported on either slurry walls or drilled caissons at both ends. Special consideration will be given to surface traffic, construction of entrance and exit ramps for traffic staging and the support of Major Utility Banks.

5.4.3 Suggested Construction Procedure

a) Install slurry wall or drilled-in caisson.

b) Excavate and install grade beams supported on slurry walls or caissons.

c) Install needle beams on grade beams and bracket to existing elevated structure columns. Each bent to be designed to allow for maintenance of surface traffic and staging for new construction.

d) Transfer dead load of elevated structure to underpinning system, by jacking or other approved method.

e) Excavate for new subsurface Tunnel Structure removing existing footings and piles of elevated structure.

f) Construct subsurface tunnel.

g) Transfer traffic from elevated viaduct to subsurface viaduct.

h) Demolish existing elevated structure/

i) Remove underpinning system and decking.

5.4.4 Materials

a) Brackets - Steel plates and bolts

b) Needle Beams - Rolled Steel Sections

c) Grade Beams - Rolled Steel Sections or Built up plate Girders

d) Caisson - 36" diameter, drilled, reinforced concrete, belled.

5.4.5 Bearing On Slurry Wall

As indicated in Section 5.4.2, the grade beams supporting viaduct underpinning will bear on either slurry walls or caissons. For the case of bearing on slurry wall, the final design must ensure that underpinning loads are distributed adequately in the longitudinal direction of the tunnel, such that the Soldier Pile Tremie Concrete (SPTC) slurry wall is not overstressed and that bearing pressure on the till is within allowable limits. Of particular concern is the tributary area of wall which carries the underpinning load. The final design will include analysis methods and appropriate details to meet these design requirements.

6.0 Construction Impact Mitigation

6.1 Introduction

Mitigation is an integral component of design and construction for the CA/T Project. The overall goal of the mitigation program is to minimize the disruptive effects of construction while maintaining the schedule, quality, and cost effectiveness of the project.

This section is intended to provide the SDC with information as well as guidelines and requirements to aid in the development of mitigation plans and specifications. It contains 1) a description of existing conditions in the project area, highlighting those that are particularly sensitive to mitigation issues, and 2) specific areas within the contract boundaries which must be addressed with mitigation strategies.

The SDC shall work with CA/T mitigation staff throughout the final design process to ensure maximum mitigation integration into the final design. Mitigation reviews will be conducted throughout the design and construction process.

6.2 Existing Conditions

6.2.1 General Description

The physical area abutting the D017A contract is primarily a retail/commercial area which attracts a large number of tourists, with Faneuil Hall Marketplace on the west side of the Artery and the Aquarium, Boston harbor cruises, Rowes Wharf, Long Wharf and the North End on the east side. Catering to pedestrians and tourists, the east side along the waterfront features pedestrian paths, parks and green spaces. Pedestrian activity is extremely heavy on both sides and beneath the Artery particularly during the summer months. There are two hotels in the area: the Marriott Long Wharf and the Boston Harbor Hotel and three residential areas: Harbor Towers, residential condominiums at Rowes Wharf, and residences in the North End.

6.2.1.1 Rowes Wharf

- Rowes Wharf is a recently renovated pier with a new brick/granite structure. There are office and residential condominiums within this building as well as the 230 room Boston Harbor Hotel. There are several retail shops on the ground floor along Atlantic Ave. The main entrances, drop off, and delivery area for the hotel are also located along Atlantic Ave.

- The waterfront area is accessible to the public and is becoming a popular spot to have lunch and view the harbor and activity at Logan Airport.

- The water shuttle services to the airport and the South Shore operate out of this area and generate substantial pedestrian activity.

- Frequent deliveries are made to charter boats that leave Rowes Wharf from April through December.

6.2.1.2 Harbor Towers/Waterfront Park

- Harbor Towers is the primary residential area within the D017A contract boundaries. It consists of two high rise concrete buildings. It is a condominium association with 624 units, a pool and a well-maintained landscaped perimeter.

- The Harbor Towers garage is located along Atlantic Avenue with access off of Milk Street and East India Row. It is a 1500 space garage, 574 of which are leased to Condominium owners and are located on the two lower levels of the garage, with an entrance on East India Road. The remainder of the spaces are available to the public with access from Milk Street. There is a restaurant facing the water which also has access from Milk Street. There are retail shops on the ground floor along Atlantic Avenue. Access to these shops is from a covered walkway owned by the building.

6.2.1.3 Central Wharf

- The New England Aquarium is located in Central Wharf. It is a primary tourist attraction in Boston with over one million visitors annually. It generates a large amount of pedestrian and bus traffic. The busiest periods are the summer months and school vacations.

- There are street vendors and trolley car parking and pick-up in the Central Wharf area.

6.2.1.4 Long Wharf

- The Marriott Long Wharf is located here. It is a 400 room hotel and conference center with two restaurants. The main entrance drop off area and garage entrance fronts on State Street. There are several street vendors operating around the perimeter of the building.

- The majority of Boston's harbor cruise ships operate out of this area, generating pedestrian activity. During the summer months there are a number of day and evening cruises leaving from this pier each day. A community ferry to Charlestown, a mitigation measure for the Central Artery North Area (CANA) project, operates from Long Wharf.

- The New England Telephone Building is located here between Central street and State Street, with an entrance on Central Street. A designated taxicab stand is behind the Telephone Company building.

- The MBTA Blue Line Aquarium station, next to the Marriott Long Wharf, has its main entrance/exit on the corner of Atlantic Avenue and State Street. This station is the major public transportation access point for Faneuil Hall Marketplace and the waterfront.

6.2.1.5 Mercantile Wharf/North End

- The Mercantile Wharf building is a renovated historic structure which has retail activity on the ground floor and office and residential spaces on the upper floors.

- 70-110 Commercial Street along Mercantile Wharf are historic, residential buildings in the North End neighborhood. The North End is a highly sensitive area because of the many residences and small businesses it contains, and because of its physical and social character which are integral to Boston's history and culture identity.

6.2.1.6 Faneuil Hall Marketplace/Marketplace Center

- This area is a major tourist attraction in the City of Boston, busiest during the summer months.

- Faneuil Hall Marketplace is a renovated market area consisting of three granite/brick buildings with numerous small retail shops, eateries and outdoor entertainment.

- Marketplace Center is the closest building in the area to the Central Artery. There are two levels of retail shops and restaurants and 15 floors of office space.

- There is a heavily traveled pedestrian connection from Faneuil Hall Marketplace through Marketplace Center to the waterfront known as the "Walk to the Sea."

- Tour buses park underneath the Artery behind Marketplace Center.

- There are two garages in this area - the Clinton Street Garage, and the Dock Square Garage.

6.2.2 Existing Conditions Inventory

An inventory of existing conditions will be completed in late fall. Base maps indicating the following information will be provided to the SDC.

1. Vehicular Movement/Nodes (some traffic counts)

2. Pedestrian Movement (some pedestrian counts)

3. Building Uses and Entrances

4. Parking and Loading Zones

5. Historic Resources

6. Recreational/Tourist Uses

7. Other Construction Activity

6.3 Mitigation Requirements

Site-specific mitigation requirements are described below. Construction Impact Mitigation, found in Appendix A of this document, outlines the general mitigation guidelines the SDC must follow.

6.3.1 Coordination

There must be coordination of construction activity with other simultaneous construction projects. The timeframes and staging of these construction activities must be considered in order to minimize construction impacts to a given area. These include, but are not limited to the following:

- Construction of a barge loading site for the CA/T Project
- South Station Transportation Center construction
- The construction of the New Northern Avenue Bridge and reconstruction of the Summer and Congress Street bridges, particularly as they relate to access to and from South Boston
- 17B MBTA Blue Line construction at Long Wharf and Atlantic Avenue. Particular attention should be focused on maintaining automobile and pedestrian flow through the State Street intersection
- Phase II of International Place construction
- Boston Gas Company relocation of a gas line down Purchase, Gridley, Pearl, Franklin, Custom House, and Clinton Streets
- CA/T utility contract D014A and D014B
- CA/T 15A mainline. Particular impact due to possible traffic diversion caused by elimination of North Street to I-93 movement.
- Dewey Square Tunnel area, D018A
- CA/T Northbound under Atlantic Avenue, D011A
- Surface restoration work, D015C

- Coordination with tunnel construction work for segment of SB tunnel and ramps from Station 106+70 to Station 120+00 (i.e., that portion not included in design contract D017A.

6.3.2 Access

Construction must be staged to ensure pedestrian and/or vehicular access and flow to key locations at all times. These locations include, but are not limited to, the following: (For further detail regarding architectural design standards for pedestrian crossings and access, refer to Section 7 of this document)

- safe pedestrian access and tour bus loading/unloading zones must be provided for the Children's Museum if any traffic is detoured past the Museum

- automobile, taxi, bus, and delivery truck access to Rowes Wharf parking, drop-off, delivery areas, and valet parking zone

- automobile, taxi, bus, and pedestrian drop-off/access to ferry services behind Rowes Wharf and the U.S. Customs Buildings

- pedestrian flow along Atlantic Avenue next to Harbor Towers, Harbor Towers Garage, and the New England Telephone Building

- vehicular access to the Harbor Tower garage

- pedestrian access to the New England Aquarium and to boats on Long Wharf

- for trolly, tour and school bus and taxi drop off stops to the Central and Long Wharf area and the New England Aquarium, and pedestrian flow from the stops to the areas

- vehicular flow through either Milk or Central Streets at all times for delivery to the New England Aquarium and the Marriott Long Wharf

- vehicular access to the Dock Square garage off Clinton Street and the garage below Marketplace Center

- automobile, taxi, and pedestrian access to Marriott Long Wharf

- pedestrian crossing on Atlantic Avenue between Marketplace Center to Columbus Park/Marriott Long Wharf (Walk to the Sea)

- emergency vehicle access into Faneuil Hall from Clinton Street and State Street, and pedestrian access through Clinton Street to Faneuil Hall

- o 24 hour emergency vehicle access through all streets
- o 24 hour access on Purchase Street to fire station and ambulance garages.

6.3.3 Noise and Vibration

Specify construction period noise abatement measures including methods for support wall excavation, and work hour restrictions which will be used to accommodate the needs of these sensitive residential and/or business locations:

- o Boston Harbor Hotel and residences at Rowes Wharf
- o residences at Harbor Towers
- o Marriott Hotel at Long Wharf
- o residences and businesses in the Mercantile Wharf Building
- o residences at 70-110 Commercial Street
- o residential buildings at the intersection of Fulton and Cross Streets

6.3.4 Historic and Other Sensitive Structures

Specific methods which will be used to minimize construction impact on as many as 12 historic structures, and any other vulnerable structures in the D017A contract area, which may require some form of special protection. The SDC must determine what measures are necessary to protect adjacent buildings and convey this protection plan to the construction contractor via drawings and specifications. The SDC shall base its determination on at least (but not limited to) the Conservator's Report, the AGC Report, and its own additional studies.

6.3.5 Parking

The business communities existing on both sides of the D017A portion of the Artery depend on the limited parking supply availability. Delineate necessary lines of construction where parking will be taken, minimizing disruptions and the taking of existing space.

- o along Sears Street
- o lot at intersection of Surface Artery and India Street
- o lot under Central Artery viaduct next to International Place Phase II

6.3.6 Critical Traffic Areas

The following lists traffic issues in the D017A contract to be specifically addressed in the final design. Multiple construction phases will be required in each of the cases described below.

- The Northern Avenue on-ramp will be removed in contract 14C. Because of the traffic sensitivity of this action, traffic staging in this area for 17A should be coordinated with the 14C traffic maintenance measures. The west service road, crossing from Northern Avenue to Congress Street adjacent to Anthony's Pier 4 Restaurant, will be built before the Northern Avenue on-ramp comes down, as a mitigation measure.

- The Northern Avenue off-ramp will be closed in this contract. An analysis of the use of the existing/closed Essex/Lincoln off ramp and related intersections will be conducted as a maintenance of traffic measure for the closing of this ramp. The results will be given to the SDC. With this additional information, the SDC must create a traffic plan for this stage of the contract.

- Traffic coordination with the construction and opening of the New Northern Avenue Bridge

- Design Congress/Atlantic and Northern/Atlantic intersections to minimize construction disruption

- Maintain two traffic lanes and one parking lane on Atlantic Avenue in front of Rowes Wharf

- Design the Atlantic Avenue/East India Row intersection construction phasing to achieve the least possible interruptions to traffic, including flow to and from the Harbor Towers Garage and Harbor Towers residences

- Design the Atlantic Avenue/Milk Street-Central Street State Street construction phasing to achieve the least possible disruptions to traffic, including flow to and from the New England Aquarium, Marriott Hotel and the Long Wharf. This will include planning for tourist vehicles, especially buses, destined to or departing from the New England Aquarium, all taxi traffic and tour trolley stopping and staging. Construction phasing shall be designed for the least possible spring/summer tourist season impact. Further, coordination with the MBTA Aquarium Station project must be specified so as to achieve the least possible simultaneous disruptive activities.

- Design the Cross Street/Commercial Street intersection construction phasing to achieve the least possible disruptions to traffic.

- Design the Cross Street construction phasing to achieve the least possible disruptions to traffic. Although the majority of traffic using the Callahan Tunnel/Government Center exit from I-93 northbound proceeds through the tunnel, at least one lane shall be maintained on Cross Street to accommodate exit ramp volume entering Cross Street.

- Design the Surface Artery/Clinton Street intersection construction phasing so as to achieve the least possible disruption to traffic. Maintain access to the existing Clinton Street Garage.

- Design the Purchase Street/Oliver Street intersection construction phasing to achieve the least possible disruptions to traffic.

- The Boston Fire Department requires a turning radius of 44 feet from the entrance/exit of their station onto Purchase Street. This will allow emergency vehicles to turn onto the street. Access onto Pearl and Congress Street for emergency vehicles must also be maintained. All vehicle exits at the facility are to be kept clear.

- Design the new High Street off-ramp intersection to allow the ramp to function during construction.

7.0 Architecture

7.1 Introduction

This chapter defines the scope of highway architecture, building architecture and landscape architecture in the I-93 Central Artery North to Congress (Section Design Contract No. D017A). Included are both temporary construction period elements and permanent preliminary architectural and landscape design solutions for the highway elements, limited urban landscape areas and Ventilation Building No. 3.

This package covers all construction phases from slurry wall construction through decking and subsequent removal of the overhead Central Artery (approximately 1998) and opening of I-93 NB and SB. A temporary landscape condition at the surface is shown identifying site improvements required at project completion.

It is assumed that a separate final design consultant team will design the permanent surface restoration plan, and that the D017A Section Design Consultant will be required to coordinate with the designer thereof. Design work relative to joint development of surface parcels is not included in the scope of this contract.

7.2 Urban Design

7.2.1 Urban Design Context

A well-considered urban design approach for this section of the Artery will enrich the architectural and landscape architecture solutions designed for the area. It needs to be based on an understanding of both the historical dynamics that have been interrupted by the Artery and existing conditions (including those which have emerged more recently and in some instances, in response to the presence of the elevated highway).

When the elevated artery was built in the 1950's, it disrupted the continuity of preexisting street patterns. The separate character of each of the neighborhoods severed by the Artery is shown in Figure 7.1. Particularly relevant to D017A are the distinctive street patterns associated with the waterfront, the financial district and the Broad Street historical area. These clearly emphasized movement across the Artery towards the harbor edge along a series of straight and long streets fanning out from the old business district. Figure 7.1 demonstrates that the Artery alignment was determined without reference to any historic or contemporary pattern of movement through the downtown. In the D017A area, the Artery cut across at least a dozen streets linking the waterfront to the downtown core. The destruction of many of these traditional movement patterns reinforces the need for construction period protection of those links that have survived

as well as bringing to the fore the need for permanent restoration plans.

Though the existing Artery is thought of as a corridor which cuts a regular swath across downtown Boston, its impact on the configuration of the abutting street pattern is irregular along the entire length of the downtown section. This is the result of both direct and indirect property right-of-way takings for the elevated roadway which arbitrarily transformed formerly active streets and truncated buildings into Artery edges. Over time the presence of the elevated roadway itself began to influence the conditions along its edges, contributing to changes or decline in use, often creating dead or only sporadically active street edges in areas made inaccessible, dark and/or dangerous. Figure 7.2 summarizes the current pattern of use along the Artery edges. It distinguishes between those building edges which are in active use (whether by pedestrians, vehicles or both) and those which are wholly inactive. Figure 7.3 roughly illustrates the extent and configuration of open space (defined by street edges and buildings) affected by the removal of the elevated section of the Artery.

The width of many of the gaps created by the depression of the Central Artery and the variety of their placement, eg., angled to and set back from rather than running parallel to the former roadway opens up considerable possibilities for their subsequent reuse. In particular, the potentially generous open space can be utilized to enhance the restoration of cross links between the waterfront and downtown, without impeding movement along the former artery alignment. The width of these openings and the visual interest of the irregular street edges lend themselves to the creation of public squares (open plazas or "nodes") through which important cross links pass. These would work to restore the traffic patterns which were interrupted by the elevated Artery while at the same time balancing the emphasis of north-south traffic which it imposed.

7.2.2 Common and Contrasting Features in the Built Environment.

In general, with the exception of the Federal Reserve Bank, buildings along both sides of the Artery within the D017A area maintain the street edge more continuously and consistently than do buildings along the stretch of corridor between North Street and Causeway. This is partly because fewer buildings were truncated by the original construction of the elevated highway along this section of its length. It is also partly attributable to more recent construction which has consciously addressed the Artery alignment (like Rowes Wharf). The building wall running from Russia Wharf through to Rowes Wharf is particularly strong (with the exception of the Boston Edison site earmarked for Vent Building No. 3). Most of the existing buildings within this stretch incorporate brick, concrete and granite in similar pink and earth tones. The buildings also are built to a roughly similar scale.

In general, buildings on both sides of the Artery share many building materials and design features. Wide variations of red brick and pink granite appear on both sides of the corridor, though buildings along the west side show more glass and steel. Overall, the building facades are more or less flat, with little surface molding and with generous and uniform window openings facing the Artery. This is as true of the Victorian brick facades (like those sitting between 125 High Street and International Place) as of newer and much larger buildings (like International Place). Many buildings (old and new) also incorporate some form of storefront elevation at the ground level, whether used for commercial or more office-related activities.

Italianate brick and granite facades, characterized by arcades at ground level and clerestories at the top appear on both sides of the corridor, typified by Russia Wharf on Atlantic Avenue and by the buildings on the north side of High Street that will face the newest phase of International Place when complete.

The primary difference in the building walls along the two sides of the Artery is one of scale. The majority of the very newest and tallest structures in the financial district are clustered on the west side. They are typically at least three times the height of their building counterparts on the east side of Atlantic Avenue. Cross sections through the Artery at most points along its length within D017A would show this relationship, with the building height dipping down to the waterfront from a maximum height on the west of Atlantic Avenue to in some cases just a few stories at the water's edge. The desire to maintain this relationship is embodied in the Harborpark I.P.O.D. which recommends a maximum height of just 55 feet for new construction along the waterfront.

The depression of the Artery provides an opportunity to draw up an urban design framework which combines the restoration of those currently disused areas along the Artery edges with future air rights development on the newly created land parcels above the downtown tunnel. The commitment to re-connect and add selected thoroughfares across the Artery corridor must be considered together with analyses of the existing architectural character, and street and traffic patterns specific to each sub-area.

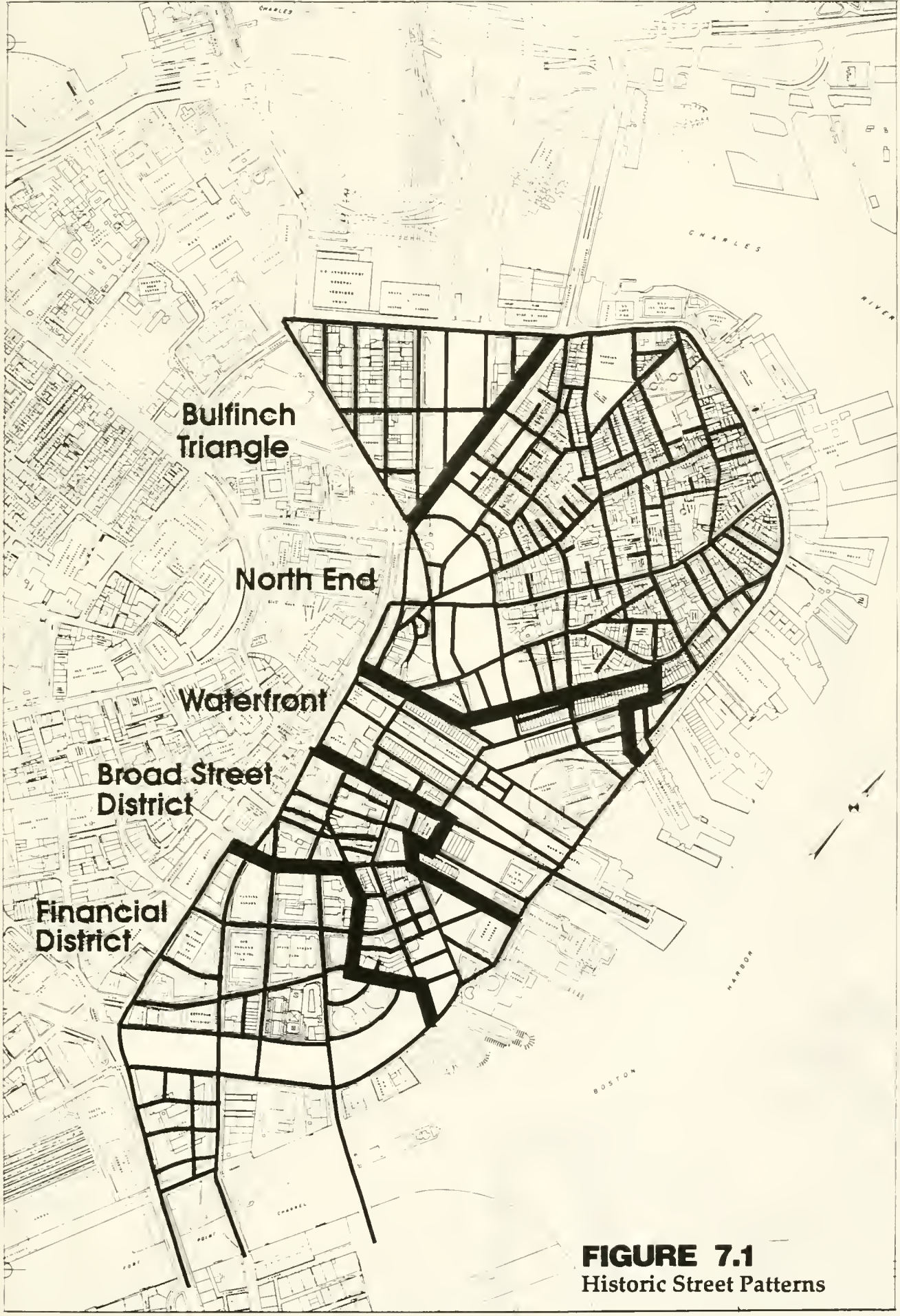


FIGURE 7.1
Historic Street Patterns

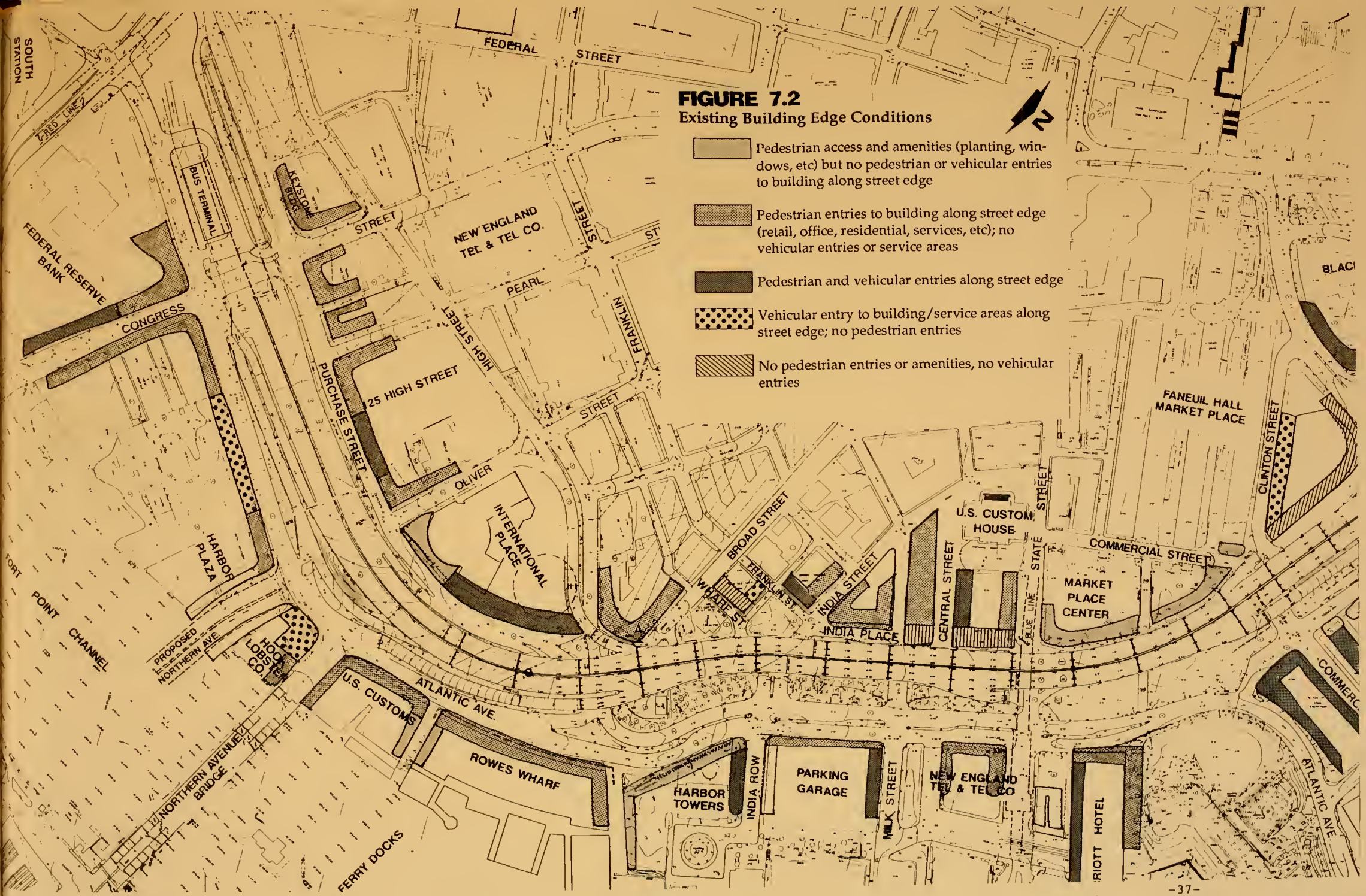


FIGURE 7.2
Existing Building Edge Conditions
Pedestrian access and amenities (planting, windows, etc) but no pedestrian or vehicular entries to building along street edge
Pedestrian entries to building along street edge (retail, office, residential, services, etc); no vehicular entries or service areas
Pedestrian and vehicular entries along street edge
Vehicular entry to building/service areas along street edge; no pedestrian entries
No pedestrian entries or amenities, no vehicular entries
SOUTH STATION
RED LINE
FEDERAL STREET
BUS TERMINAL
KEYSTONE BLOCK
NEW ENGLAND TEL & TEL CO.
PEARL STREET
HIGH STREET
FRANKLIN STREET
FEDERAL RESERVE BANK
CONGRESS STREET
PURCHASE STREET
25 HIGH STREET
OLIVER STREET
INTERNATIONAL PLACE
HARBOR PLAZA
FORT POINT CHANNEL
PROPOSED NORTHERN AVE.
HOOD LOBSTER CO.
U.S. CUSTOMS
ATLANTIC AVE.
NORTHERN AVENUE BRIDGE
ROWES WHARF
FERRY DOCKS
HARBOR TOWERS
INDIA ROW
PARKING GARAGE
MILK STREET
NEW ENGLAND TEL & TEL CO.
RIOTT HOTEL
BROAD STREET
FRANKLIN ST.
WHARF ST.
INDIA STREET
INDIA PLACE
CENTRAL STREET
BLUE LINE
STATE STREET
U.S. CUSTOM HOUSE
COMMERCIAL STREET
MARKET PLACE CENTER
FANEUIL HALL MARKET PLACE
CLINTON STREET
ATLANTIC AVE

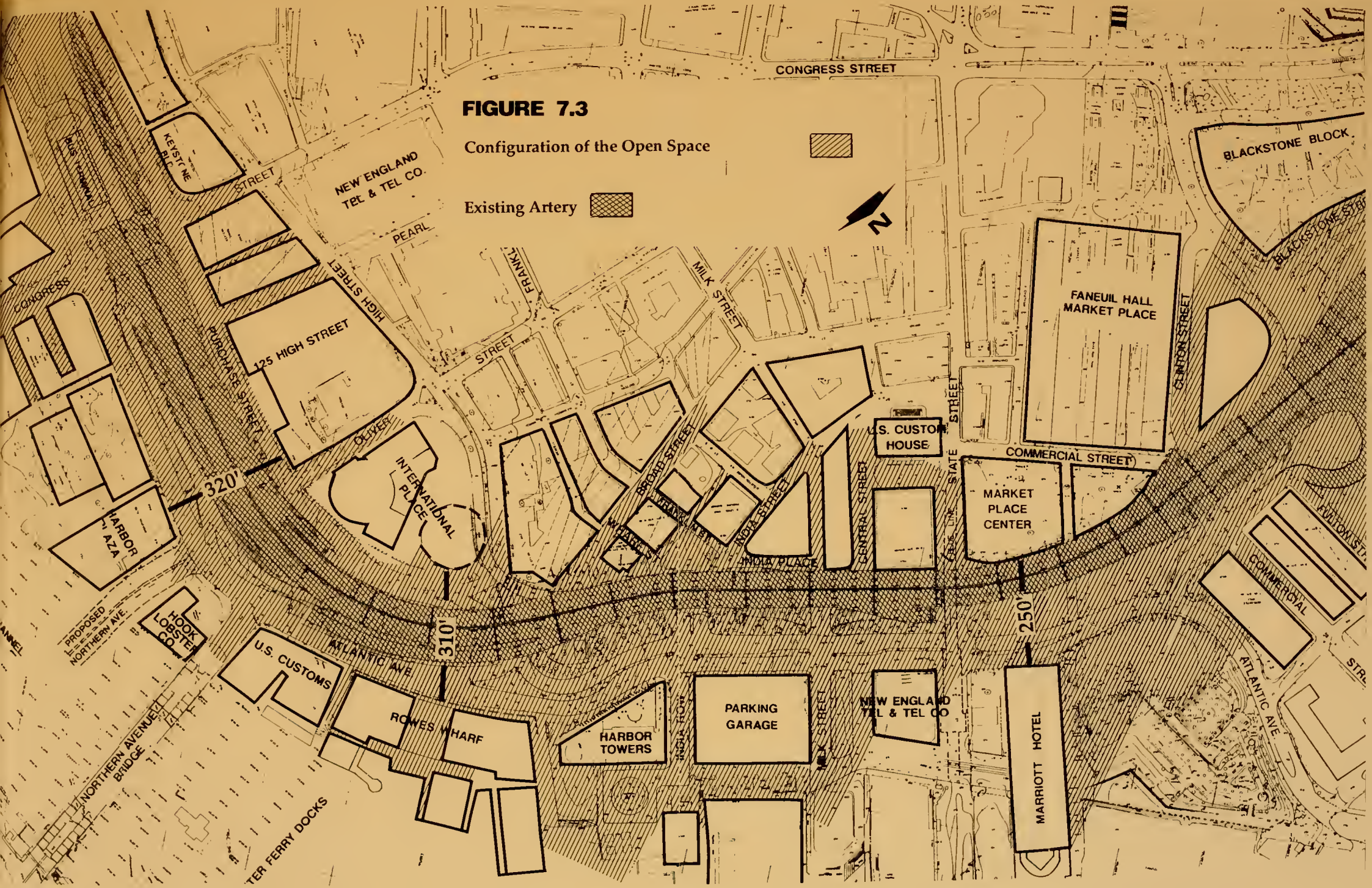


FIGURE 7.3
Configuration of the Open Space
Existing Artery
N
CONGRESS STREET
KEYSTONE PLACE
NEW ENGLAND TEL & TEL CO.
PEARL STREET
HIGH STREET
125 HIGH STREET
PURCHASE STREET
OLIVER STREET
FRANKLIN STREET
MILK STREET
BLACKSTONE BLOCK
BLACKSTONE STREET
FANEUIL HALL MARKET PLACE
CLINTON STREET
U.S. CUSTOM HOUSE
STATE STREET
COMMERCIAL STREET
BROAD STREET
CENTRAL STREET
INDIA STREET
INDIA PLACE
MARKET PLACE CENTER
INTERNATIONAL PLACE
320'
HARBOR PLAZA
PROPOSED NORTHERN AVE. BRIDGE
HOOK LOBSTER CO.
U.S. CUSTOMS
ATLANTIC AVE
310'
ROWES WHARF
NORTHERN AVENUE BRIDGE
HARBOR TOWERS
PARKING GARAGE
NEW ENGLAND TEL & TEL CO
250'
MARRIOTT HOTEL
COMMERCIAL
ATLANTIC AVE

7.3 Highway Architecture

7.3.1 Portals, Ramps and Boat Section Walls

Portals

Portals to be designed in this contract (see Drawing Nos. AR9-PD-H-001 and AR9-PD-H-002 are associated with the urban ramps and boatwalls.

Ramps

Exit Ramp CS-SA to the Surface Artery is a continuation of ramp CS-SA which originates in Design Section D015A. The Final Section Design Consultant for D017A will be required to coordinate with the Final Section Design Consultant thereof.

Ramp CN-SA reaches grade and appears at the surface across the development parcel from Ramp CS-SA. The architecture of these two ramps at the Dock Square Garage should be coordinated by this Final Section Design Consultant.

Ramps CS-P and A-CN reach grade in the development parcel adjacent to International Place and Rowes Wharf. The architecture of these two ramps should be coordinated by this Final Section Design Consultant. The design of portals is intended to differentiate between the mainline and ramp portals. The mainline portal facade is designed with the projectwide standard of precast concrete ribs stepped back in plan and section with an exit portal distinguished from the entry by inverting the facade to indicate traffic direction. Use of the project standard emphasizes the mainline and establishes the Causeway portal as part of the overall highway architecture.

Ramp portals are to be expressed as a continuation of the adjacent boat section wall enclosure; these urban portals are not designed to appear as separate visual elements. The ramp portals shall be stone patterned or rusticated consistent with the boat wall surface pattern, and shall provide a field for the coordinated location and mounting of traffic control equipment and signals. Landscape planters may be integrated into the portal wall design.

Ramps and Boat Section Walls

Urban ramps are designed to allow for the visual differentiation between on-ramps and off-ramps when seen from city streets. Entries and exits will be designed as gateways integrating signage, boat walls, pilasters and overheight attenuators. The ramps, boat sections and related secondary lights, signs, and railings are the elements of the highway which must be most closely integrated with the urban fabric at the surface.

Rustication, or patterning, on ramp retaining walls in this contract will be consistent with the Project Design Criteria, i.e., a combination of vertical and horizontal scoring. The direction, spacing and size of the score lines will vary for each ramp's geometry. (See Directive Drawings DD-H-107, 108, 109).

Pilasters are located 70 feet on center unless noted otherwise. At this time, no joint development consideration is required. Secondary elements, such as signs, graphics and lighting supports, are to be located in coordination with the regular spacing of pilasters to achieve overall design goals expressed in the Highway Architecture Concept Report.

A vertical architectural pylon is located at the exits from and entrances to ramps. It will identify the Interstate Highway System. This element will make the entry/exit more visible to surface drivers and to those driving cars merging onto city streets. It also serves as a safety warning to pedestrians, particularly at the exit ramps where vehicles are not readily visible until close to the exit nosing. It also alerts pedestrians walking next to a ramp that there will be traffic on both sides.

The pylon is designed as a support for the high vehicle attenuator at entrance ramps as well as signage if required. This structure (see drawing AR8-PD-H-020) will meet functional requirements to visually distinguish the urban ramp entry for the benefit of surface drivers and pedestrians and to provide a vertical sign support.

On the at-grade surface side of the ramps, portals and retaining walls a zone will exist which must be designated to relate to the surrounding urban condition; including sidewalks, open space, buildings and streets.

Since the final restoration of the surface is not in this contract, the design of walls related to the highway must anticipate a future final surface restoration: grading, paving, planting and site improvements.

The interim design of surface treatment in these zones should provide for safe vehicular and pedestrian movement. In addition, it provides an opportunity to express local considerations, such as neighborhood history and character through art and urban space development, enhancing the rich pedestrian environment for which Boston is well known.

The surface side of the permanent retaining walls will be designed within a family of treatments, including a pedestrian-scale treatment for seating, planting, lighting, walkways and signage.

The vehicle side of the ramp walls will be designed to accommodate the construction constraints of the slurry wall and cast-in-place walls. A cast-in-place finish surface will be attached to the

slurry wall. At the C.I.P. finish wall, the batter, shape and texture of the finish will be as described in the Directive Drawings.

Architectural finishes at the ramps will vary in length, form, height and depth. Treatment of parapet walls will be stone veneer with a continuous pedestrian rail.

Gore wall conditions at ramps SA/CS/CASB, CS-SA/CS-CT, CS-ST/SA-CT, ST-SA/ST-CN and ST-CN/CANB will receive architectural treatment to forewarn drivers of merging or diverging roadways. Common walls, where possible, are framed and opened to allow visual penetration to and from the merging lanes.

7.3.2 Tunnel Egress

To provide for the life safety of tunnel occupants in the event of an incident within one of the tunnel bores, cross passages and egress stairs are being provided at regular intervals along the alignment. The approximate location of these elements is provided in the following sections.

7.3.2.1 Cross Passages

Cross passage locations were desired every 300' along the mainline bores, and within 300' along the ramp bores. Due to the grade difference between adjacent bores and the difficulty of inserting stairs between the bores, it has not been possible to provide cross passages in every desired location. At this time the following approximate cross passage locations have been verified:

- CASB (108 + 00) to R-R (108 + 150)
- CASB (108 + 00) to R-T (107 + 80)
- CANB (110 + 00) to R-T (110 + 80)
- CASB (111 + 00) to R-T (110 + 80)
- CASB (113 + 90) to R-T (113 + 70)
- CANB (113 + 00) to R-T (113 + 70)
- CANB (119 + 00) to CASB (119 + 20)
- CANB (122 + 00) to A-CN/R-T (22 + 00)
- CASB (122 + 00) to A-CN/R-T (22 + 00)
- CANB (125 + 00) to A-CN (25 + 00)
- CASB (125 + 00) to A-CN (25 + 00)
- CANB (128 + 00) to CASB (128 + 00)
- CANB (131 + 00) to CASB (131 + 00)
- CANB (131 + 00) to CN-SA (31 + 00)
- CANB (134 + 00) to CASB (133 + 90)
- CANB (134 + 00) to CN-SA (34 + 25)
- CANB (137 + 00) to CASB (136 + 80)
- CANB (140 + 00) to CASB (139 + 80)

7.3.2.2 Egress Stairs

Egress stair entrances have been located at alignment stations at which cross passageways are also located to maintain 300' spacing between egress points.

In general, the preferred location for egress stairwells is within gores or between adjacent bores rather than outside of the tunnel slurry walls. However, this approach has not always been possible within the Contract D017A limits.

Potential stairwell locations were tested against the following constraints:

1. There must be less than 1000' between points of safety.

2. There must be space either within a gore, within the structure of the tunnel bores, or outside of the slurry wall, to locate a stairwell.

3. There must be at least one nearby open space at grade in which to locate the headhouse which does not conflict with the proposed surface street, urban design, or joint development plans. Alternatively, an adjacent building basement or nearby ramp boat section may be used.

4. There must be a clear vertical and/or horizontal path from the tunnel level to the egress discharge site which does not conflict with the new utility locations.

Based on these criteria, the following stairwell locations have been determined:

- Station 140, exit from northbound bore
- Station 140, exit from southbound bore
- Station 131, exit from southbound bore
- Station 125, exit from southbound bore
- Station 116, exit from northbound bore
- Station 109, exit via Vent Building No. 3

The stairwells are spaced substantially less than 1000' apart. This is due to the difficulty of finding suitable headhouse sites spaced an even 900' apart, the desire to keep the required stairwell and headhouse sizes manageable, and the expectation that some established locations may be altered in the future.

7.3.2.3 Egress Structures

The new emergency egress/access structures fall into four categories:

1. Headhouses adjacent to new ramp boat walls and exiting to the ramp walkway.

2. Headhouses located on parcels likely to be jointly developed in the future.

3. Headhouses located on parcels likely to remain undeveloped.

4. Headhouses developed in coordination with a MBTA subway exit headhouse.

Overall, the headhouse design shall identify the elements as part of the CA/T project by use of the same family of materials and forms as other CA/T architecture. At the same time, each headhouse must be successfully integrated with its immediate surroundings to minimize its visual and physical impact on the pedestrian and automotive activities of the street.

In particular:

1. Headhouses adjacent to boat walls shall be fully integrated with the boatwalls both in form and material. They shall be made "invisible" and shall not protrude into the streetscape.

2. Headhouses located on parcels likely to be jointly developed shall be designed as freestanding elements which are likely to be fully subsumed or substantially altered by the future site development. During the interim period between project completion and joint development, they are likely to be the sole occupants of these sites.

3. Headhouses located on parcels likely to remain undeveloped shall be designed as permanent freestanding elements. These elements can be integrated with their surroundings by the inclusion of other functions such as information Kiosk, concession stand, artwork, signage, benches, etc.

7.3.3 Tunnel Finishes

The goals for the final design of the architectural finishes in the I-93 tunnel are as follows:

A. Driver safety and Orientation

Architectural finishes provide lane definition, assist in the legibility of signage, support rapid identification of cross passages/emergency exits and support the ambient light levels required for driver visibility. Graphics in the tunnel finishes will assist drivers in understanding their geographic location.

B. Ease of Maintenance

Architectural finishes should minimize facility and replacement costs. This will be accomplished by specifying appropriate materials which create surfaces that are easy to clean with standard tunnel wash equipment, and which resist corrosion related to entry of water into the finishes and connections.

C. Aesthetic

Architectural finishes provide a more pleasing aesthetic experience for drivers which in turn will provide the driver with a sense of security and confidence while driving through a restricted underground environment.

7.3.3.1 Wall Finishes

The wall finish selected for the I-93 Central Area tunnel will be a separate finish wall, consisting of a glazed high density ceramic tile over a backer board and corrosion-resistent subframe (consistent with Project Design Criteria, Section VI - Architectural Article 2.3.4 Tunnel Walls). The wall finish, including subframe, should measure approximately 6 inches in thickness. Grout color should be selected such that the joints are not highlighted. Tile joints should be normal to the roadway. Allowance for expansion of the tile work should be provided 15' on center and whenever expansion joints in the structure are provided as a minimum. Wall panel shall be removable at standpipe locations.

Ventilation ports at side-exhausted tunnels are required. Spacing and size of ports are per D020B consultant. This consultant shall coordinate ports for alignment to wall, ceilings, and graphic design.

Wall finish at portal flank walls is to be polymer concrete. Close coordination with the portal design is required.

The graphic design for the tunnel finishes will be developed by the Graphic Design consultant and coordinated by this final section consultant around the following general guidelines:

1. Graphics are to be created by tile arrangement patterns, glazed tile surface patterns, or combination of both in conjunction with other tunnel finish elements. The size of the tile is to be determined by the Section Design Consultant in conjunction with the graphic design. Tile joints are to be normal to the roadway elevation.

2. Graphics are to be two-dimensional, and shall not cause protrusions from the wall finish surface nor create joints where corrosion might occur.

3. Graphic treatment on the walls of the tunnel should also reinforce lighting zones. The general design approach, including the colors to be used on the tunnel walls and ceilings, is provided in the Graphic Design Guidelines Manual, an appendix to the Architectural Design Criteria. Signage for utility rooms, cross passages, egress stairs, colors, for standpipes, fire extinguishers, colors for handrails and any visible sign supports will also be specified in the Graphic Design Manual.

   The SDC shall develop the graphic treatment in conjunction with the graphic design consultant.

7.3.3.2 Ceiling Finishes

The tunnel ceiling finish is to be concrete-filled porcelain enameled panels, as described in Article 2.3.3

Tunnel Ceiling Systems of the Project Design Criteria, Section VI - Architectural. The ceiling is suspended below the tunnel roof slab with a structural support system (see Section Structural Design) to form the tunnel exhaust air plenum. At certain locations, the ceiling panels will be attached directly to the tunnel roof slab. The ceiling will be installed horizontally when viewed in cross section rather than be superelevated with the roadway (see Preliminary Design Drawings). Gaskets shall be provided between panels to provide an airtight seal for ceilings that serve to create the exhaust air plenum.

The ceiling panel design and configuration act to reinforce the spatial distinction between travel lanes and shoulder or gore areas in two ways. First, those panels located over the travel lanes shall be colored white, while those over shoulder areas shall be grey. Secondly, the grey panels shall be recessed in relation to the white panels. The transition between the tile wall finishes and the ceiling panels is to be accomplished by means of a flexible coved element. (See Drawing AR8-PD-H-041). White panels shall continue into the portal facade to emphasize lane locations. The ceiling panels shall be removable and structural supports shall be detailed to provide for expansion and contraction due to temperature change. The cove panels shall be removable at Utility Room Locations from the roadway level.

Lighting Fixtures/Ceiling Panel Interface

Lighting fixtures are to be mounted in a continuous trough centered over lane markers in the tunnel. The trough is a corrosion protected steel channel into which the luminaire is inserted. The fastening of the trough to the ceilings and of the lights to the trough will be detailed to be corrosion-proof. Spacing of the luminaires shall be as regular and uniform as possible. The spacings, numbers and locations of the fixtures are shown on the Electrical Directive Drawings.

A special lighting fixture is required to illuminate signs. This fixture will be attached to the ceiling system. All holes in ceiling panels are to be pre-punched before ceiling finish is applied. All lighting fixtures will be furnished and installed by others.

Signage/Ceiling Panel Interface

Roadway signs are supported by sign mounts which are in turn supported by the tunnel structure (see PDR Section 5.0 Structural Design). The support structure requires provision of prefabricated openings in the ceiling panels, through which the sign mounts will hang. These openings are shown on Drawing DD-H-002. The sizes and locations of these openings shall be coordinated with the D020A Section Design Consultant. Sign alignment is parallel to the ceiling alignment.

Ventilation/Ceiling Panel Interface

Ventilation air ports will be fabricated into the ceiling panels (see Drawing DD-H-001). These ports will be located and sized by the D020B Section Design Consultant. The air ports will be fitted with an adjustable closure plate to control the opening size and consequent air exchange volumes. The closure plate will be coated with a corrosion protection material and mounted on the top surface of the ceiling panel. The fastening will be detailed to be corrosion-proof. The development of final details of the air ports will require close coordination with the D020B Section design Consultant.

Miscellaneous Interfaces

The Integrated Project Control System will require equipment such as Closed Circuit Television (CCTV), AM/FM Rebroadcast and linear thermal heat sensors. Embedments for equipment and their supports are the responsibility of the D017A SDC. Coordination with the D020B SDC will be required.

D015A SDC will coordinate with adjacent tunnel SDC's for all tunnel finishes.

7.3.3.3 Walkway Finishes

Tunnel walkway finishes are to be consistent with Article 2.3.5 Tunnel Walkways of the Project Design Criteria, Section VI - Architectural. These consist of facing panels of precast polymer concrete. Polymer concrete will extend to the transition walls of the portal facade. Three non-typical conditions exist, as follows:

1. The continuous linear recess above the curb on both sides of the roadway is interrupted at supply air flue locations. The recess is to be dark in color to minimize the visibility of the flue locations as shown on the Architectural Standard Drawing SD-H-002.

2. At the tunnel portal where the walkway meets the roadway grade.

3. Non-typical panels exist where dimensions must be adjusted to respond to alignment curvature crossover stairs or other dimensional variance. These panels will be sized according to unique dimensional requirements in each instance.

7.3.3.4 Roadway Level Entrances

Cross Passages

Cross passages connect separate tunnel bores and may be either within or independent of tunnel structural walls. Limited space for fire protection and communications equipment in the tunnel may

be required in the crossover. (See 11.0 Electrical Systems, and Section 12.0 Integrated Project Controls System (IPCS), and Sections 10.0 Mechanical Systems).

Materials and finishes are to be consistent with the Project Design Criteria, Section VI - Architectural, Article 2.8.5 Utility Rooms and Cross Passages.

Doors or pairs of doors will be operated with a sliding mechanism, since swinging doors could obstruct the walkways and impede emergency egress (approval of the Boston Fire Department will be required). Walls and doors shall be fire-rated. Panel walls are to be designed to support the equipment shown on the directive drawings. Equipment weights, dimensions, and connection details must be coordinated with the D020B and D022A Section Design Consultants.

Emergency egress signs shall be provided by the D017A SDC. Graphics associated with all rooms should convey their identification number and the availability of telephone, fire extinguisher or other life safety features. Design of graphics for signage is by others. Coordination will be required. The Section Design Consultant shall incorporate the approved graphic design concept into the design drawings.

Utility Rooms

Utility rooms are provided in general every 300 feet on either side wall of the tunnel. They are used for housing the IPCS equipment, such as RTU's and sign controllers, and in some cases fire protection equipment. Materials, finishes and doors are to be as described for cross passages above. Panel walls are to be designed to support equipment shown on the directive drawings. Equipment weights, dimensions, and connection details must be coordinated with the D020B and D022A SDC.

Low Point Pump Stations

Low point pump stations (LPPS) are anticipated. The finish details for the LPPS are similar to those described above for the cross passage.

7.3.3.5 Handrails and Guardrails

All handrails must meet applicable dimensional and strength requirements. Guardrails will be provided at crossovers. Refer to Projectwide Criteria.

7.3.3.6 Wall Openings

Wall Openings will be provided in the structural wall to accommodate fire extinguishers and standpipe hose valves. White porcelain enameled steel doors will be provided at each of these locations to protect this equipment from the tunnel environment. These doors are to be designed by the SDC. See D020B Drawing SD-M-013. The wall chase for the hose valve opening shall be removable tile panel.

7.3.4 Secondary Elements

Traffic signals and control systems, signage, and lighting are not in this contract; they are in the scope of Section Design Contract D022A. The location of sign supports will be coordinated in this contract. It is important that locations of sign supports be located within the dimensional framework of the ramp architectural grid, integrated within the architecture of the pilaster and walls which define the roadway. Ramps, pilasters are spaced 70'-0" on center (unless noted otherwise).

Consistent with the Projectwide Design Criteria, ramp lighting will be mounted at the pilasters. Signage and over-height vehicle attenuators will be mounted at the ramp pylons. Embedments for all lighting will be in this contract. Coordination is required.

In the urban areas where the portals and ramps meet city streets, protective screening is not desirable. However, it may be desirable to use landscape planters integrated with the boat and portal walls to maintain a greater separation of pedestrian to vehicular traffic. These elements will vary according to the specific site and parcel development anticipated.

7.3.5 Construction Period Kit of Parts

Mitigation measures must provide for the comfort and convenience of both drivers and pedestrians travelling through or near construction activity. Three northbound and three southbound lanes of surface traffic flanking construction zones must be maintained throughout all construction stages. Safe crossings must also be maintained on surrounding local streets directly affected by construction activity.

A system of construction period elements has been designed to provide a "kit of parts" from which a variety of modular walkways, protective screens and supporting signage can be assembled to help mitigate pedestrian passage through construction zones.

The covered walkway system is protective, flexible, movable and durable and creates an environment which the user perceives as secure and comfortable. Design criteria for the walkways and associated elements are described below in Section 7.3.5.1 and illustrated on Standard Drawings SD-H-401, 402, 403. Criteria governing the location and various applications of the kit-of-parts within or adjacent to construction zones are specified in Section 7.3.5.2 below and illustrated in Figures 7.4 and 7.5. The drawings illustrate the application of the kit-of-parts to slurry construction, decking construction and excavation mitigation.

Within the D017A area there are two major pedestrian crossings - Walk to the Sea - which connects City Hall Plaza to Waterfront Park via Market Place Center - and State Street. A special thematic gateway will be designed for the entrances to each of

these walkways which reflects its current and historical role within the downtown area. Gateway design imagery may also be enhanced through the use of secondary kit-of-parts elements, eg., kiosks with signage, planters, trash receptacles. The final designer will design the thematic gateway panels with reference to the Graphic Design Manual.

Other existing pedestrian pathways across the Artery will also incorporate gateway structures which must be maintained in a safe and usable manner at all times during the construction period. They include the following crossings:

- o Milk Street
- o India Street
- o High Street to Rowes Wharf
- o Congress Street

These crossings together with the Walk to the Sea and State Street are located on Figure 7.6.

Preliminary Design Drawings (AR9-PD-L 011, 012, 013, and 015) identify the locations of walkways and areas within D017A requiring some form of mitigation for pedestrians.

7.3.5.1 Kit of Parts

Modular System for Pedestrian Protection and Information

A system of modular walkways, protective fencing and supporting signage can be assembled from a "kit of parts" to help mitigate pedestrian passage through and adjacent to construction zones (see DD-H-402). The interchange elements will be coordinated to create a visually integrated set of components which will be easily recognizable to pedestrians and drivers. The system includes:

1. Pedestrian Covered Walkway

A modular shelter based on a flexible system of elements will be used to provide overhead pedestrian protection from inclement weather and airborne construction debris. The shelter will be flexible, movable and durable as well as welcoming and reassuring to the public. (See DD-H-401, 402).

Each walkway shall be designed to:

- o have a typical clear internal section of 8'-" x 8'0" to accommodate three people travelling abreast (with two in wheelchairs); the minimum allowable width will be 6'0".

- o accommodate wall panels that are open to natural ventilation except where they must be solid for purposes of visual display or additional protection; solid panels must be painted in compliance with project-wide graphic standards; where used for protection, they must include glazed viewholes. (See DD-H-401 Panel Types);

- o accommodate variably angled turnings (from 5 - 90 degrees) over its length while maintaining a continuous waterproof enclosure, a nonskid walking surface and maximum change in grade between walkway sections of 1/2 inch;

- o maintain an even walking surface; over areas with uneven ground conditions, walkway sections may be jacked or may sit on top of evenly spread levelling material;

- o accommodate continuous roofing for protection from weather, dust and debris; joints between walkway sections must be covered;

- o provide lighting at each 10 foot bay;

- o accommodate lateral openings along its length to permit access to shops or buildings where necessary;

- o be accessible to people with disabilities according to criteria set out by the Massachusetts Architectural Barriers Board, providing ramps with maximum slope of 1:12 to all walkways and maintaining them throughout the construction period;

- o incorporate sign bands inside walkway and on any visible exterior edge (see DD-H-401); project-wide graphics shall be applied to wall panels and roofing, as appropriate (see Project Graphic Design Manual, Appendix).

2. Gateway Structures

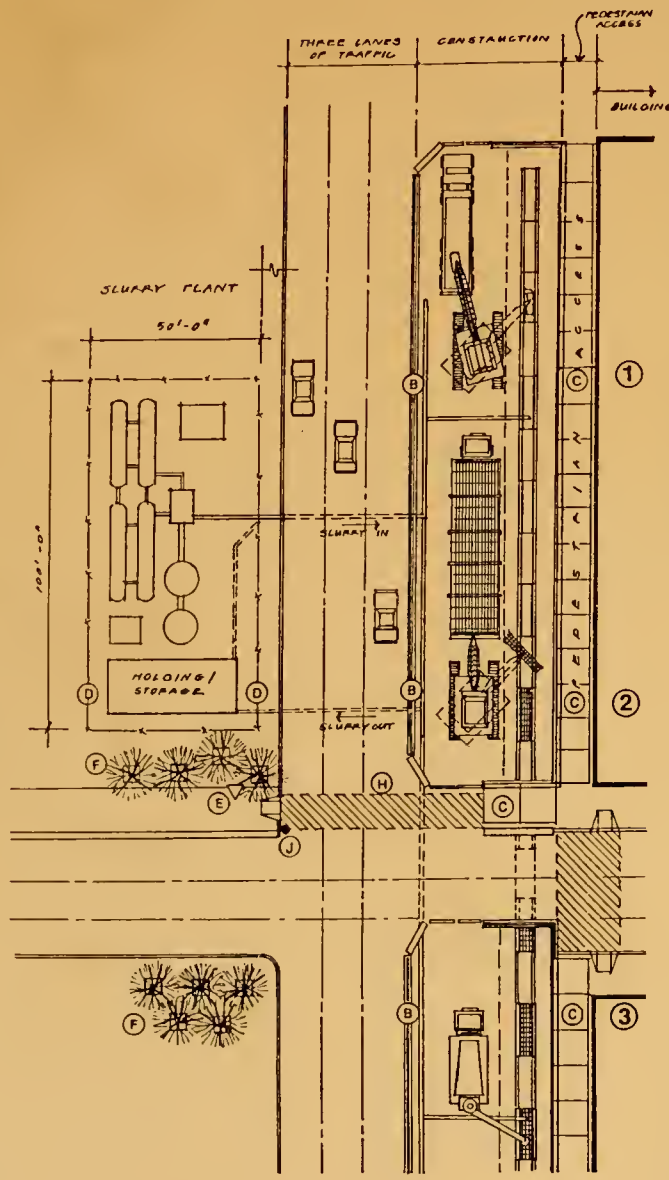
All covered walkways crossing the Artery corridor will incorporate gateway structures (Drawing SD-H-403) built by the contractor which will flank the entries at both ends. These structures will have special graphic panels applied to them, designed by the final designer with reference to the Graphic Design Manual. For crossings of special significance [the Freedom Trail, Walk to the Sea, State Street], gateway design will draw on some aspect of local historical significance to create an appropriate sense of place for each location. Though the walkways at these major crossings (identified in the Preliminary Design Reports) may be relocated several times within a designated crossing zone, the gateway structures leading to them should be installed beyond the slurry walls at the edge of the construction zone so that they can remain in place throughout the construction period (see DD-H-403). For other cross-corridor walkways, gateway structures may either remain fixed or may move as the walkway itself is relocated. The height of gateway structures shall exceed the height of the covered walkway by a minimum of 1'6" and shall be located to be visible from a distance of 1/2 block. The gateway treatment must include colors and graphic elements common to the pedestrian protection and information system.

3. Information Kiosk

The kiosk will incorporate project-wide graphics which will supply way-finding assistance at or near the entrances to covered walkways (see DD-H-403).

4. Construction Barricade

The barricade will consist of a jersey barrier base with panels above, (see DD-H-403). A sign band displaying project-wide graphics will be affixed at the standard height above the panels.



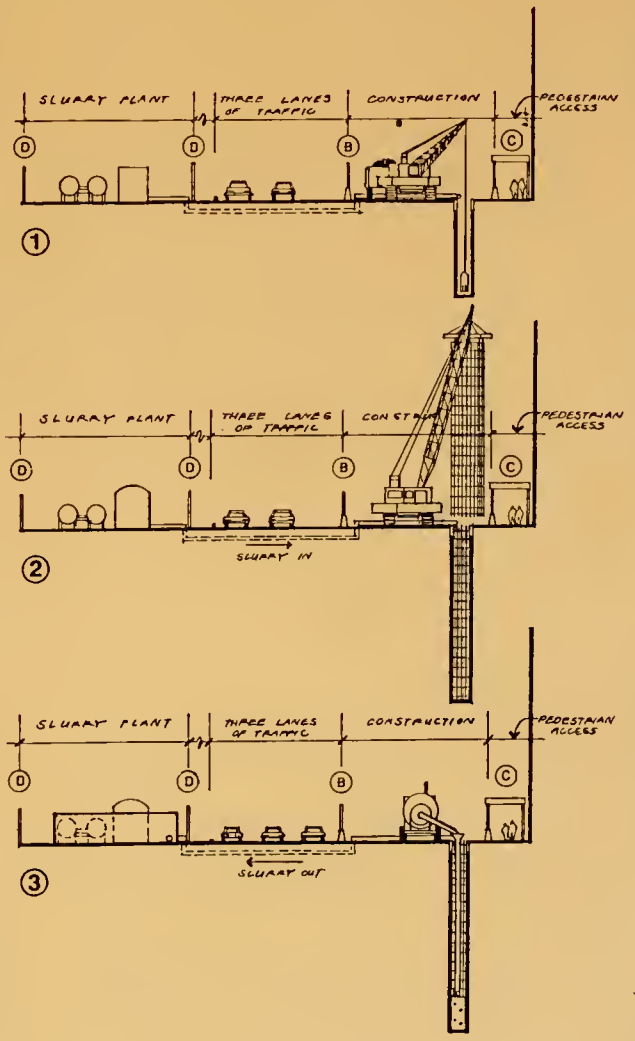
SLURRY WALL CONSTRUCTION
PROTOTYPICAL CONDITIONS/PLAN

The construction zone, 30' to 40' wide, will be seperated from public accese by a continuous concrete barrier broken only by removable wooden berriers used for construction vehicle ingress and egress. When required for public safety, construction operation protection or dust and debris containment, a 6'-10' high fence will be afixed to the concrete berrier. Safe pedestrian accese and three lanes of moving vehicular treffic (in each direction, north and south) will be maintained throughout all of the construction stages. Pedestrian and/or vehicular crosseings through construction zones (east and west, perpendicular to Central Artery corridor) will be provided within designated zones.

The proposed slurry wall location will be surveyed and steked. Guide walls will be placed on either side of the proposed slurry wall alignment. A crane equipped with a clam shell bucket will excavate alternating sections, approximately 15' long, between the guide walls. Materials from the 50'-100' deep trench will be loaded onto dump trucks and carried to the barge loading facility, treatment plant or land fill site.

Bentonite slurry, piped from an on-site slurry plant, will fill the trenches and stebilize the trench walls. Steel reinforcing cages will be lifted and placed into the slurry-filled trench by a crane.

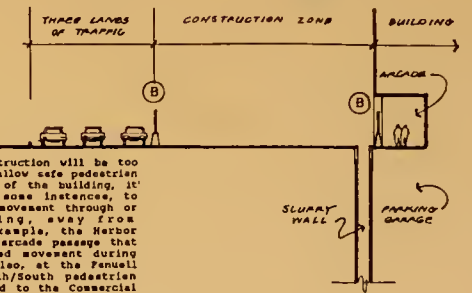
Concrete, delivered to the site in transit mixer trucks, will be placed into the bottom of the trench by use of a hopper and tremie pipe. As the concrete fills the trench, the bentonite slurry will be displaced and will be pumped back to the slurry plant where it will be held in storage and reprocessed for future use. As the concrete-filled trenches cure, the entire process will be repeated for the alternating 15' sections between the completed concrete wall sections. For the length of one city block, approximately 250 feet, and assuming a 100 foot depth, a duration of 5-6 weeks should be expected for completion of one continuous slurry wall.



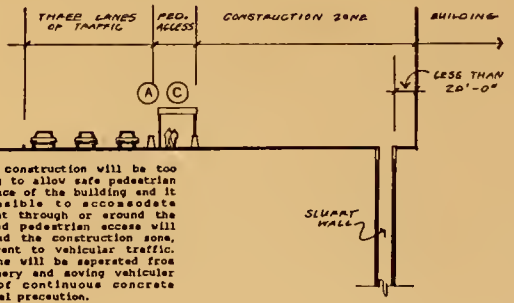
SLURRY WALL CONSTRUCTION
PROTOTYPICAL CONDITIONS/SECTION

KEY: KIT-OF-PARTS

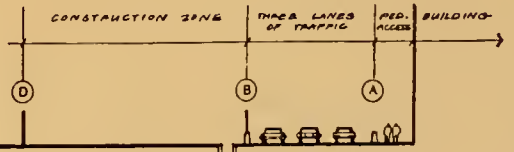
(A)	CONCRETE TRAFFIC BARRIER	
(B)	CONSTRUCTION BARRIER	DETAIL 7 SD-H-403
(C)	PEDESTRIAN COVERED WALKWAY	DETAIL 1 SD-H-402
(D)	CONSTRUCTION FENCE	DETAIL 4 SD-H-403
(E)	INFORMATION/DIRECTION KIOSK	DETAIL 5 SD-H-403
(F)	FIBERGLASS PLANTER	DETAIL 1 SD-H-403
(G)	GATEWAY STRCTURE	DETAIL 6 SD-H-403
(H)	SAFETY STRIPING	
(J)	CROSSING BEACON	DETAIL 3 SD-H-403



When slurry wall construction will be too close to a building to allow safe pedestrian access along the face of the building, it will be possible, in some instances, to accomodate pedestrian movement through or around the building, away from construction. For example, the Harbor Towers Gerage has an arcade passage that will allow uninterupted movement during close construction. Also, at the Faneuil Hall Marketplace, North/South pedestrian movement can be directed to the Comercial Street route which is a short distance from the parallel Surface Road access, interupted by construction.



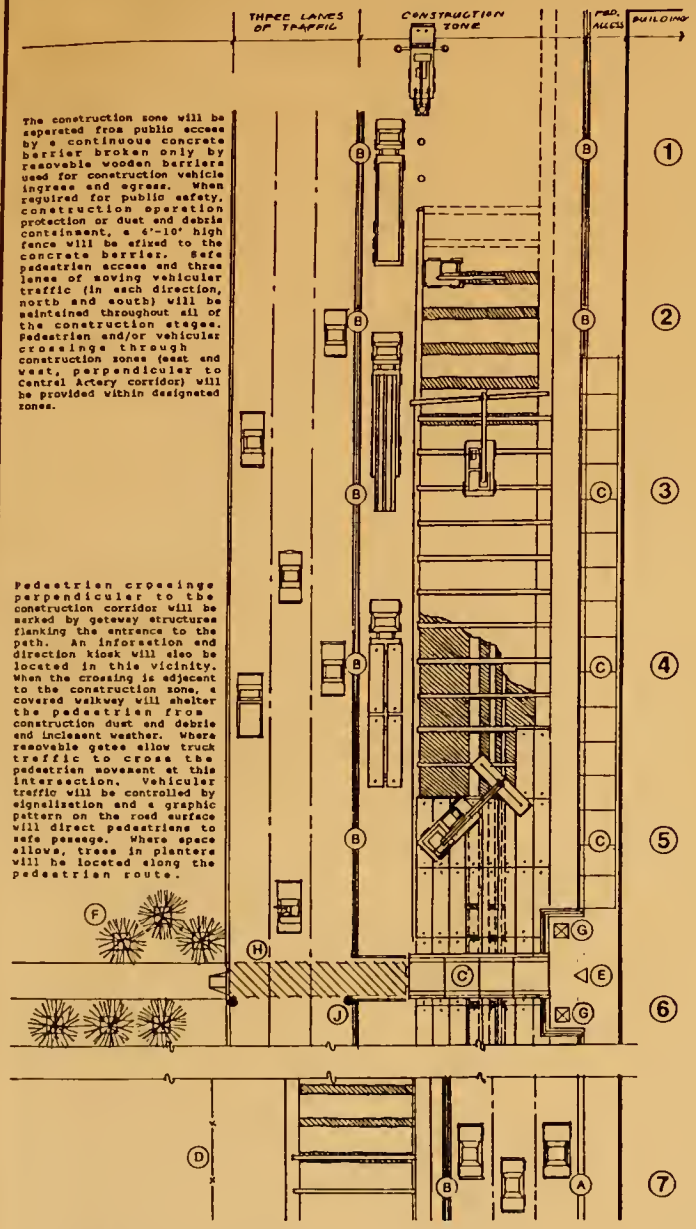
When slurry wall construction will be too close to a building to allow safe pedestrian access along the face of the building and it will not be possible to accomodate pedestrian movement through or around the building, protected pedestrian access will be provided around the construction zone, parallel and adjacent to vehicular traffic. This pedestrian zone will be seperated from construction machinery and moving vehicular traffic by use of continuous concrete barriers as a minimal precaution.



When slurry wall construction will be far enough removed from the face of a building to allow safe pedestrian access along the face of the building, the pedestrian zone will be seperated from construction activities by a concrete berrier and/or protective fencing. When moving traffic will be adjacent to the pedestrian access and a curb no longer exists as a separation, a concrete berrier will be used to distinguish the pedestrian zone from the vehicular.

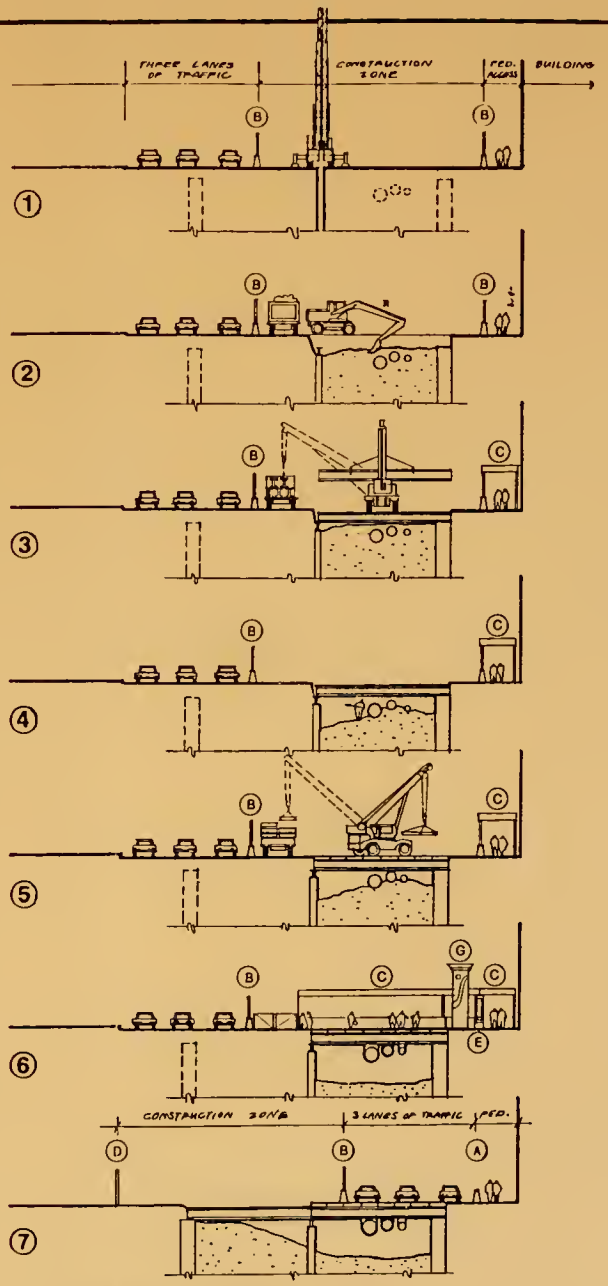
SLURRY WALL CONSTRUCTION
SPECIAL CONDITIONS/ SECTIONS

FIGURE 7.4 Slurry Wall Construction


THREE LANES OF TRAFFIC
CONSTRUCTION ZONE
FED. ALLEY
BUILDING
The construction zone will be seperated from public access by a continuous concrete barrier broken only by removable wooden barriers used for construction vehicle ingress and egress. When required for public safety, construction operation protection or dust and debris containment, a 6'-10' high fence will be erixed to the concrete barrier. Safe pedestrian access and three lanes of moving vehicular traffic (in each direction, north and south) will be maintained throughout all of the construction stages. Pedestrian and/or vehicular crossings through construction zones (east and west, perpendicular to Central Actery corridor) will be provided within designated zones.
Pedestrian crossings perpendicular to the construction corridor will be marked by gateway structures flanking the entrance to the path. An information and direction kiosk will also be located in this vicinity. When the crossing is adjacent to the construction zone, a covered walkway will shelter the pedestrian from construction dust and debris and inclement weather. Where removable gates allow truck traffic to cross the pedestrian movement at this intersection, vehicular traffic will be controlled by signalization and a graphic pattern on the road surface will direct pedestrians to safe passage. Where space allows, trees in planters will be located along the pedestrian route.
A
B
C
D
E
F
G
H
J

DECKING CONSTRUCTION
PROTOTYPICAL CONDITIONS/PLAN

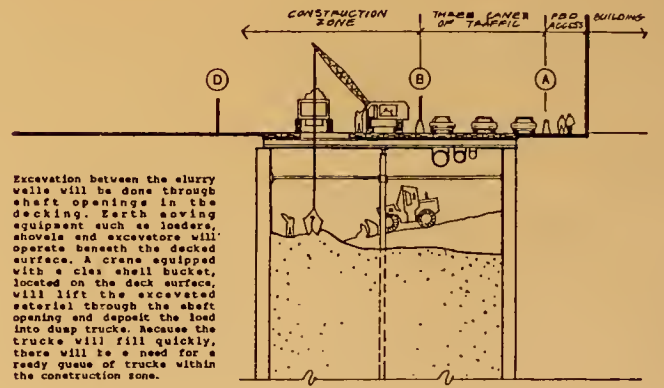
1. In order to shorten the beam span between slurry walls, temporary pins or post piles will be placed approximately 10' on center in a line parallel to the slurry walls. Holes for the pilings will be drilled to a depth equal to the slurry wall depth. After the pilings are placed, they will be connected by a beam set on top of the pile.
2. The area between the slurry wall and the pin or post pile beam will be dug out to receive the deck beams. A backhoe excavator will be used to remove the excavated material and load it into a dump truck, which will carry the materials to the barge loading facility, treatment plant or land fill site.
3. A crane will lift the deck beams from the bed of the delivery truck and place them to bear on the slurry wall and pin or post pile beams.
4. Further excavation between deck beams and around existing utilities will then be done. Because of the fragility of many utility structures, much of the excavation will need to be done by hand. Utilities will remain in the location in which they are found. Some existing services may be relocated to accomodate excavation.
5. Planking panels (wood or concrete) prefabricated to specifications that accomodate the span between the deck beams, will be lifted from the delivery truck bed and put into place by a crane. Panels will be approximately 4'-0" wide, 10'-0" long and 12" thick.
6. Once the panels are in place, the utilities will be suspended from the deck beams, still in their original locations, vertically and horizontally. Material beneath the utilities will then be carefully removed.
7. When the decking procedure has been completed, vehicular traffic can then move to the decked area. The entire procedure will then be repeated until the area between two slurry walls is completely covered and excavation can continue beneath the decking.



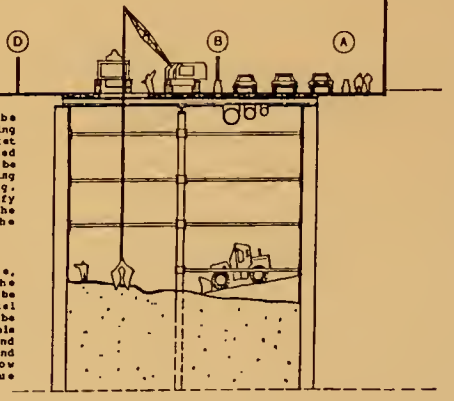
DECKING CONSTRUCTION
PROTOTYPICAL CONDITIONS/SECTION

KEY: KIT-OF-PARTS

(A)	CONCRETE TRAFFIC BARRIER	
(B)	CONSTRUCTION BARRIER	DETAIL 7 SD-H-403
(C)	PEDESTRIAN COVERED WALKWAY	DETAIL 1 SD-H-402
(D)	CONSTRUCTION FENCE	DETAIL 4 SD-H-403
(E)	INFORMATION/DIRECTION KIOSK	DETAIL 5 SD-H-403
(F)	FIBERGLASS PLANTER	DETAIL 1 SD-H-403
(G)	GATEWAY STRCTURE	DETAIL 6 SD-H-403
(H)	SAFETY STRIPING	
(J)	CROSSING BEACON	DETAIL 3 SD-H-403



Excavation between the slurry walls will be done through shaft openings in the decking. Earth moving equipment such as loaders, shovels and excavators will operate beneath the decked surface. A crane equipped with a clam shell bucket, located on the deck surface, will lift the excavated material through the shaft opening and deposit the load into dump trucks. Because the trucks will fill quickly, there will be a need for a ready queue of trucks within the construction zone.

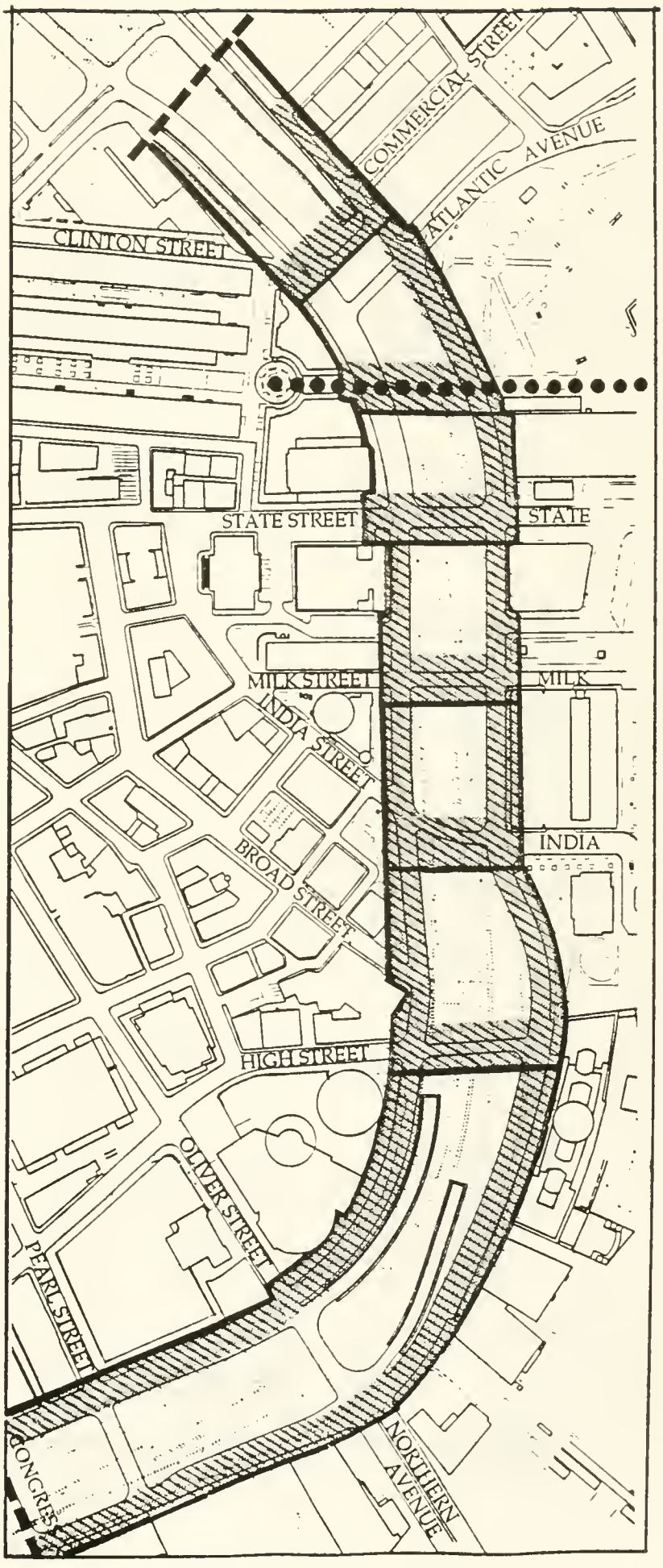


A signal person will be stationed beneath the decking in the area of the bucket contact with the excavated material and another will be stationed above the decking at the shaft opening. Together they will clarify communications between the crane operator and the excavator.

As excavation proceeds, lateral pressure on the slurry walls will need to be counteracted by horizontal bracing. This bracing will be placed at regular intervals throughout the length and depth of the excavation and its placement will allow excavation to continue unimpeded.

EXCAVATION PROCEDURE
PROTOTYPCAL CONDITIONS/SECTION

FIGURE 7.5 Decking Construction and Excavation



LEGEND

N

PEDESTRIAN ZONES TO BE MAINTAINED DURING CONSTRUCTION

NORTH AND SOUTH LIMITS OF D017A

THE WALK TO THE SEA

FIGURE 7.6

Pedestrian zones requiring mitigation

5. Construction Fencing

Fencing will be chain link with a sign band at the standard height used for the covered walkway, information kiosk and construction barricade.

6. Planters, trash barrel, and pedestrian crossing beacon

These will be manufactured products which will be visually liked to the kit of parts imagery through the use of project-wide graphics. A minimum of two trash barrels will be used at the entrances to each covered walkway. Planters shall be used outside of the construction zone to screen construction activity and fencing and to strengthen pedestrian awareness of gateway locations.

Kit of parts layouts shall be site-specific and designed by the final designer to follow construction phasing plans. Elements from the kit may be used for additional project-related purposes not specified here, eg., to provide covered shelters for tour bus operations.

7.3.5.2 Criteria For The Location And Application Of Pedestrian Walkways

1. Construction zones shall be separated from public access by continuous fencing and construction barricades, interrupted only by removable barriers used to allow the ingress and egress of equipment and construction materials.

2. For additional protection, temporary roadway protection shall be applied along the length of the site perimeter corresponding to the section of slurry wall under construction at any one time; this shall be moved along the perimeter, following the course of slurry wall activity. Where covering is required, it must be compatible with design and maintenance standards specified in SD-H-401, 402.

3. Established pedestrian crossings under the Artery shall be maintained throughout all construction stages and shall be separated from vehicular traffic.

4. The covered walkway will be employed at all times except when it is interrupted for the passage of traffic where safety striping and ramps will be provided. Walkways not passing directly below the Artery may be covered or uncovered, depending on their proximity to construction activity and specific circumstances of each location.

5. Wherever possible, these walkways will maintain their existing width; where reduced by construction demands, a minimum allowable width of 6'0" shall be maintained.

6. Where walkways disgorge pedestrians into vehicular traffic, traffic signaling, lighting, safety striping on pavement or

decking and pedestrian crossing beacons at each end of the walkway shall be provided to ensure safe passage in compliance with city requirements.

7. Where walkways begin or end at a mid-block location, provision must be made to guarantee wheelchair access, in compliance with state accessibility requirements for a corner location.

8. Where the boundary of construction activity occurs within 5' of an existing sidewalk or temporary pedestrian route, the pedestrian zone will be separated from construction activity by a continuous barrier and/or protective fencing (see SD-H-406, 407) for protection measures required by specific building operations.

9. Where moving traffic runs alongside pedestrian access and a curb no longer exists to separate them, a continuous jersey barrier will be used to distinguish the pedestrian zone from the vehicular zone.

10. Site perimeter fencing will sit between 10'-12' beyond slurry wall activity. Where it is not possible to maintain a minimum (6'0") walkway width, pedestrian traffic must be rerouted; where necessary, protected pedestrian passageways shall be provided along the opposite flank of the construction zone, running parallel and adjacent to the north-south vehicular traffic. These walkways will be separated from the construction zone and from traffic by construction barricades or covered walkway sections. Information kiosks including site maps and directional signage shall occur wherever the existing path is disrupted.

11. Where there is a choice of location between sides of an intersection, a walkway shall be located on the side with the greater volume of pedestrian traffic.

Maintenance Provisions

Throughout the construction period, walkways must be properly maintained, kept lit, dry, clear of snow and ice, painted; signage must remain legible and accurate as walkway changes location. This will be the responsibility of the contractor.

7.4 Introduction - Vent Building No. 3

7.4.1 Urban Design Context

Vent Building No. 3 will occupy a newly created parcel adjacent to the Artery, about 31,500 square feet in area on the south/east side of Atlantic Avenue between Northern Avenue and Congress Street (See Figure 7.7 Vent Building No. 3 Location Map). A Boston Edison substation sits just beyond the boundary of this parcel in the middle of the block between Atlantic Avenue and the waterfront. The SEIS suggests that "a mixed use ventilation

building on the Boston Edison site would bring activity to the Channel's edge and would hide the substation transformers". The discussion below considers the urban design context in which building on this site will take place. It includes a summary of existing regulatory and legislative constraints and references to surrounding buildings and site uses which might have a bearing on Vent Building No. 3.

7.4.1.1 Regulatory and Legislative Constraints

Section 106 of the National Historic Preservation Act

This agreement between the Advisory Council on Historic Preservation, the FHWA, and Massachusetts State Historic Preservation Office is designed to protect properties either included or eligible for inclusion in the National Register of Historic Places which might be adversely affected by the CA/T project. Section 106 sets out a review procedure to be followed and a process for the derivation of guidelines for joint development on any listed property. Specific design development guidelines pertaining to Artery-related construction within the Fort Point Channel area include the requirements that:

- the "design and location of the ventilation building...(be) sympathetic to, and respectful of, the characteristics of surrounding historic properties with regard to massing, color, building material, detail and scale; considerations will serve to mitigate the adverse visual impacts on any historic properties like Russia Wharf which are adjacent to a proposed ventilation building.

- preliminary, final design and construction specifications of any proposed building be submitted for review, prior to the start of construction, to the Massachusetts SHPO in consultation with the Boston Landmarks Commission.

Chapter 91

State legislation requires the licensing of any building proposed on land that is deemed to be filled tidelands. The exact definition of what constitutes filled tideland and therefore subject to Chapter 91 has not been finally established. The most recent definition, however, appears to narrow the range to include primarily that area running between the water's edge and the first dedicated right-of-way (in this instance, Atlantic Avenue). The site for Vent Building No. 3 falls exactly within this area and therefore requires Chapter 91 licensing.

Licensing depends on proposed uses which serve some water-related public purpose. This requirement explains the frequency of proposals for waterside parks attached to schemes which are not wholly or primarily water-related (eg., Rowes Wharf, the Long Wharf Marriott). Vent Building No. 3 is the only project-related ventilation facility to require Chapter 91 licensing. Unlike Vent

Buildings 6 and 7 which provide the ventilation for the Third Harbor Tunnel, Vent Building No. 3 vents a tunnel running under ground rather than under the sea. This means that it is not serving what is primarily a water-related activity and so falls within the scope of the legislation.

A new set of regulations will shortly be introduced restricting the range of permissible developments to those whose primary functions are considered to be more directly related to or dependent on their waterfront location. Proposals for development must be evaluated by the Coastal Zone Management Office.

7.4.1.2 Environmental Considerations

Bureau of Waste Site Cleanup

If hazardous materials (PCBs, etc.) or oil are found on the proposed site for Vent Building No. 3, it will be subject to the Massachusetts Contingency Plan which requires Department of Environmental Protection notification, site assessment and remediation. Soil testing is not scheduled to occur on D017A until the fall of 1991 at the earliest (240 days after the Notice to Proceed), as part of a separate consultant contract.

Other Considerations

The presence of the electricity transformers and related equipment on the site raises the question of safety and associated health concerns in connection with the human occupation of space adjacent to or near the substation. The primary concern is the possible harmful effect of electromagnetic fields generated by the transformer and associated apparatus.

The second possible danger or environmental nuisance is that of noise; the substation emits a noticeable hum. This could be easily masked by the use of acoustic panels or tiles.

Finally, there is some concern about the location of the supply air intake in relation to the transformer. In the event of a transformer fire (which has occurred recently on another site) - air intake located in the immediate vicinity of the transformer could fill the tunnel with smoke, possibly before the system had been turned off.

7.4.1.3 Zoning

All zoning requirements will be subject to negotiation and review with the BRA.

The VB No. 3 site falls within M4 District, zoned for restricted manufacturing, an FAR of 4 and maximum allowable building height of 150'. The site also falls within Subdistrict E of the Harborpark Interim Planning Overlay District (IPOD). For the

Inner Harbor Waterfront area within the IPOD, the land use objectives are to provide for continuous public access along the water's edge, to restrict height and massing to inhibit the construction of high or dense walls near the waterfront which might block the movement of sea breezes or interrupt sea views and to promote an acceptable mix of commercial, residential and recreational land uses that create a smooth transition between the high-density downtown area and the lower density uses associated with water-dependent activities. In support of these guidelines, the interim height standard for Subdistrict E is 55 feet.

Among relevant articles of the zoning code are:

- Article 13, "Dimensional Regulations" require a minimum parapet setback of H+L/6 where H="height of building above the height below which no setback is required" and L="length of wall parallel (or within 45 degrees of parallel) to lot line, measured parallel to lot line"; same regulations (Table B) requires a minimum rear yard depth of 12 feet.

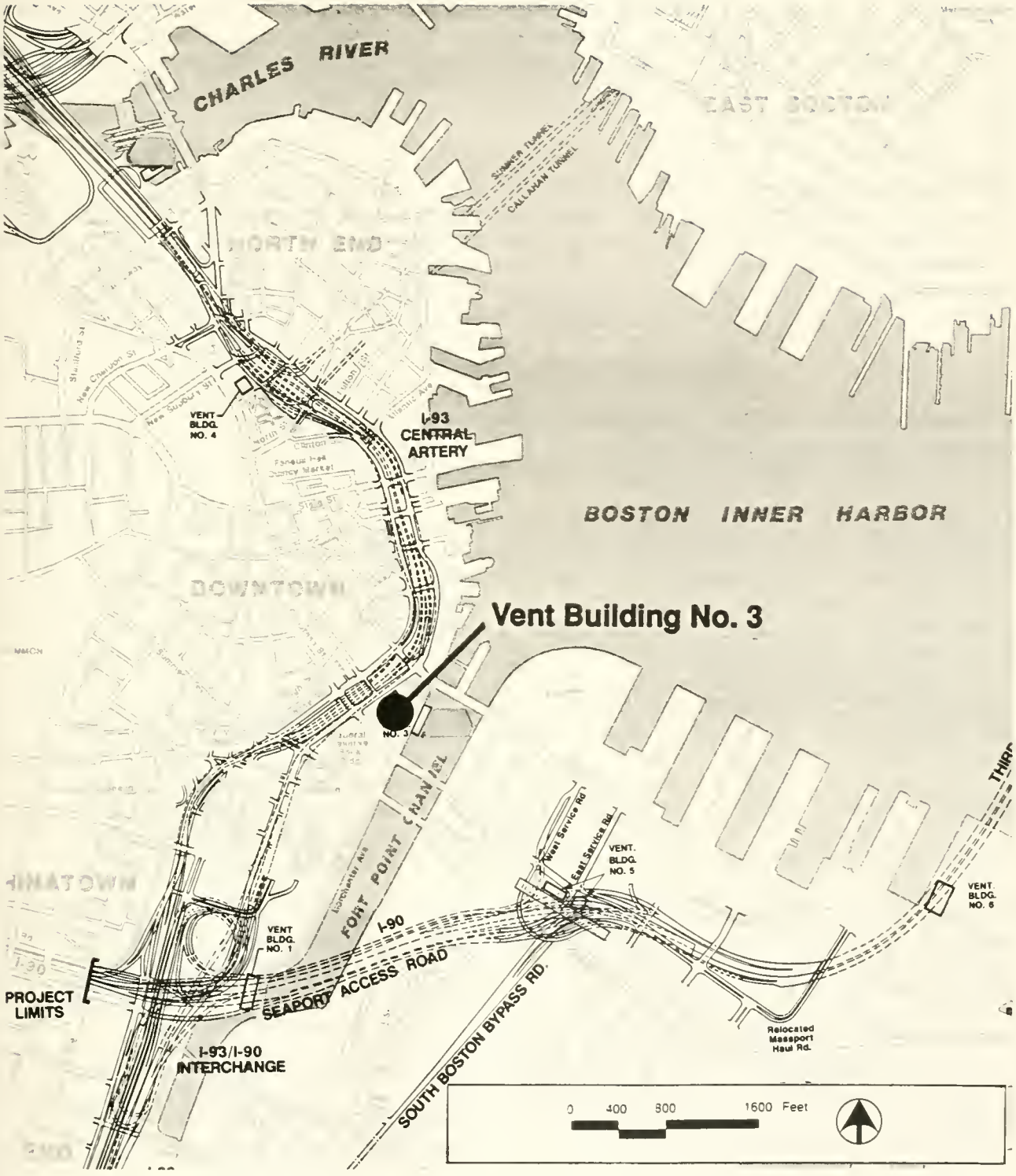


FIGURE 7.7 Vent Building No. 3 Location Map

- Article 16, Section 16-3 - "Height of buildings - exceptions adjoining nonconforming structures" may apply to joint development on this site: 470 Atlantic Avenue, which flanks its northern edge exceeds the M4 height limit of 150 feet by 15 feet. The zoning code provides a formula to arrive at an adjusted allowable height in this context.

- Article 25, Flood Hazard Districts: The site sits within a special flood hazard area (subject to a one percent probability of flooding in any given year - the 100-year flood). The flood plain level is 113'; existing sidewalk level is 112'. Ground floor level may require raising to a level higher than currently exists.

7.4.1.4 Impact of the Surrounding Environment

This section identifies surrounding properties and highlights those physical attributes and other characteristics which have implications for the design of Ventilation Building No. 3.

- Russia Wharf: Flanking the southwest boundary of the site are three seven story Victorian warehouses built in 1898 which comprise Russia Wharf. Fronting on both Atlantic Avenue and Congress Street, they were constructed of concrete, granite and brick and are listed in the National Historic Register. The elevation fronting on the Artery (540 Atlantic Avenue) has a two story granite base 36 feet high surmounted by a further five stories of light brown brickwork, rising to a cornice line (with dentils below) at a height of 86 feet and an overall building height of 101 feet. The building frontage of Atlantic Avenue is roughly 177 feet in width. The end elevations of the warehouses facing the southwestern flank of the Vent Building No. 3 site are virtually windowless (for more details, see section 7.4.4 below, "DESIGN GUIDELINES").

- 470 Atlantic Avenue: Fronting Atlantic Avenue on the northern side of the site is a 165-foot high office- block built in 1926 (Harbor Plaza). Currently painted two tones of gray, darker at the base and lighter above the second floor level, this is the building's third resurfacing since it was constructed. Harbor Plaza runs the full length of the block between Atlantic Avenue and the Fort Point Channel waterfront. The longer, northeastern wall of the building will be directly exposed to four lanes of vehicular traffic from the New Northern Avenue bridge when it opens in 1991.

- Boston Edison Substation: Immediately adjacent to the southeastern boundary of the Vent Building No. 3 site is an active Boston Edison substation outlined on Figure 7.8.

Boston Edison requires 30-foot wide access with a 25-foot high clearance running from Atlantic Avenue along the back walls of Russia Wharf. Under the most recent surface roadway scheme, this

access road continues the view corridor across the Artery from Pearl Street. Required access then angles across the back of the site to the water's edge, following the alignment of underground cables which pass into Fort Point Channel to South Boston.

There is an emergency transformer which is currently located along the Russia Wharf party wall. Its location constrains vehicular access to the back of the site as well as limiting the volume of the building envelope. It is technically possible to relocate the transformer to another location on the site.

- MBTA People Mover: Though the MBTA People Mover was originally planned as an accelerated mass transit improvement in conjunction with the now abandoned Fan Pier Project, the MBTA still hopes to construct it. The MBTA has not yet announced a construction date; it has, however, recently released an Environmental Impact Statement.

The MBTA expects the Artery "to accommodate" the People Mover and "not to do anything to preclude it". It is currently designed to cut across the northern boundary of the Vent Building No. 3 site. Located in a corridor sitting directly over the proposed Central Artery tunnel, its depth corresponds to the first sublevel of the vent building.

- International Place: Due north from the Vent Building No. 3 site across the Artery is the recently completed first phase of International Place, 46 stories, 600 feet high. Phase II, 35 stories high, will be completed in June 1992.

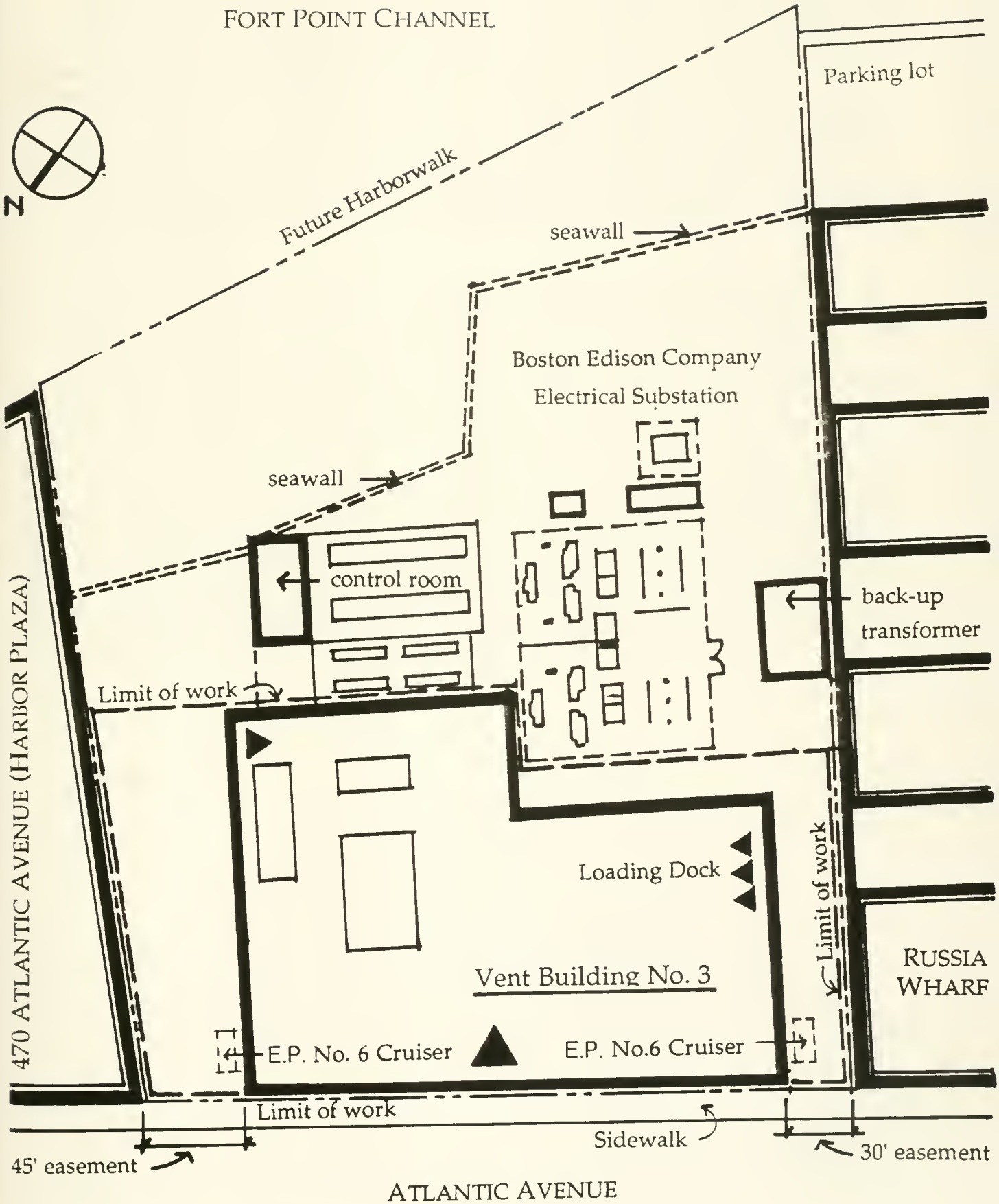


FIGURE 7.8 Boston Edison Substation and Vent Building No. 3 Site

- Central Artery Joint Development Parcel 19: Directly facing the Vent Building No. 3 site will be a newly created parcel of land roughly 69,700 square feet in area above the tunnel structure. Though joint development of up to 8-10 stories is theoretically possible on this site, the requirement to accommodate the People Mover on the northbound side of the Artery tunnel severely limits the depth needed to provide additional structure within the tunnel box to support joint development above. This constraint suggests that any future building development on the parcel may well involve some setback from the street. Development proposals on this parcel will be subject to Joint Development guidelines for historic preservation.

- Northern Avenue Bridges: The new Northern Avenue Bridge is expected to replace the existing bridge by late 1991. Located approximately 182' south of the existing bridge (and 182' feet closer to the VB #3 site), it will be the main connector between the downtown area, Fort Point Channel and South Boston Harborfront. It will also allow direct access for traffic from South Boston to the Northbound lanes of the Artery.

The bridge will be a fixed span concrete structure, supported by four sets of piers, two in mid-Channel, and will accommodate pedestrians on 12 ft. wide walkways on either side of the bridge. The new bridge's clearance over mean high water will be 16 feet, high enough to allow power but not sail boats to pass beneath it. There are currently several proposals for the future of the existing Northern Avenue bridge, ranging from demolition to renovation for reuse as either a pedestrian bridge or a pedestrian and vehicular bridge combined.

7.4.2 Site constraints

A full discussion of the urban design context of the site and of the regulatory framework governing it, is given in section 7.4.2 above. This section considers only those constraints that effect the development of the required ventilation facility on the site.

Setbacks

Though BRA zoning requires only 5'0" setbacks from Russia Wharf and 470 Atlantic Avenue, Boston Edison, owner of the site, has more extensive setback requirements related to the servicing and maintenance of the substation it operates. In practice, these require a 30' setback from Russia Wharf to allow access to and removal of equipment and a 50' setback from 470 Atlantic Avenue for the barging and related materials excavation.

Clearances

Boston Edison requires 25' vertical clearances along the back of Russia Wharf and angling out to the waterfront over an underground cable and along the boundary with 470 Atlantic Avenue. It also requires a 45' vertical clearance over the transformers. The proposed MBTA People-Mover will require a subsurface easement.

Zoning

The Vent Building No. 3 site fell within Subdistrict E of the Harborpark Interim Planning Overlay District (IPOD) now lapsed. The underlying zoning is M4, which permits restricted manufacturing, an FAR of 4 and a maximum allowable building height of 150'. The vent building, as designed, has one floor above ground which begins at a height of 36 feet above grade (level with the top of the arcade at Russia Wharf) and rises to an overall building height of 56 feet.

Floodplain

Because the site sits within a special flood hazard area, ground floor level must be above the flood plain level of 113'. Existing sidewalk levels on the Atlantic Avenue side vary around 111'.

7.4.3 Design Guidelines

In compliance with the FEIS the design of Vent Building No. 3 "will be compatible with nearby historic buildings and districts. The incorporation of retail frontage along Atlantic Avenue will enhance the pedestrian environment. The building will be designed as an extension of the adjacent Russia Wharf's facade with cornice line, fenestration, and granite arcade compatible with Russia Wharf's facade articulation. Special architectural treatment of the stacks can make them a positive addition to the area. The new structure will screen the existing Boston Edison substation from motorists' and pedestrians' view on Atlantic Avenue, a positive visual impact in this area. Service access for Boston Edison will be on the south side of the parcel." (Part I, p. 9-16)

A contextual response on the vent building site will strengthen the existing building wall along the eastern side of Atlantic Avenue which, from the intersection with Congress Street to the end of Rowes Wharf, already displays considerable consistency of materials, form and scale. Adding to this established urban pattern will reinforce a building tradition which is appropriate both for the more formal Atlantic Avenue elevation and for the character of the historic waterfront.

Variations of the building tradition to which Russia Wharf belongs abound in the immediate vicinity of the vent building site. Directly across the Artery and facing it sits a modest cluster of low red and brown brick buildings, some with similar Italianate detailing. These, including the Richardson Block, form the Gridley Street District, eligible for listing on the National Register by agreement of the SHPO and FHWA. Another, smaller cluster of Victorian brick buildings (also eligible for listing on the National Register as the Oliver/Purchase Street District), sits opposite the Harbor Plaza Building at 470 Atlantic Avenue.

Although these guidelines ask for a clear response to the primary architectural patterns of the surrounding buildings, this does not call for any literal replication of their design or detailing but rather for an intelligent acknowledgment and adaptation of the most relevant features.

7.4.3.1 Atlantic Avenue Elevation

On the Atlantic Avenue side, the vent building should express some relationship to Russia Wharf. This it can do by acknowledging some of the more distinctive design features of the Atlantic Avenue facade (see Figures 7.9 and 7.10). These include:

- A change of material at an elevation of 36 feet, from granite to brick, separating the arcade from offices above. This is accompanied by a change in the scale of wall opening, with large open an almost square expanses within the stone elevation giving way to pairs of small rectangular windows above. The vent building could acknowledge this change by either introducing a setback or a change of material at this level and by making some equivalent shift in the scale of wall openings above and below it.

- Warm colored materials on the Atlantic Avenue side - primarily light brown brickwork, cream and pink granite (the material used in the restoration of Russia Wharf was Milford granite). Across the elevated Artery from the vent building site, both International Place and 125 High Street are clad in materials which echo the pinkish hue of the Russia Wharf granite. The vent building should use materials in the mix which is consistent with and draws upon the colors of these surrounding buildings.

- The building height of 100 feet should be marked on the vent building in some way (eg., setback, change of material, change of pattern of fenestration, etc.). The cornice line at a height of 86 feet marking a "clerestory floor" above, might also be acknowledged in some way but is deemed to be of less significance that the overall building height.

- The windows above the arcade level and below the cornice line form a uniform pattern. They are all set in pairs at 20 foot intervals with the exception of the last column of single windows marking the chamfered arcade turning the corner into Congress Street. The windows in this single column are about a foot narrower than each of the windows in the pairs (roughly 5 feet wide instead of 6).

- A clerestory above the cornice line formed of paired and rounded windows are of the same narrower width as the single column of windows on the Congress Street end. Reading vertically from the top down, the basic width of wall opening increases twice, from about 12'6" across the pair above the cornice line, to about 13'6" for the four intermediate levels (between arcade and cornice) to about 15'6" across the openings at the arcade level.

- The symmetry of the facade is centered on a rounded arch opening, which distinguishes it from the flat-topped openings to either side. The opening is further distinguished by the rustication in the plane immediately surrounding the arch and by metal filigree above.

- The sculpted decorative silhouette centered on top of the front elevation is a small echo of the eagle on top of the South Station entrance. Other decorative features which create some relief on the facade include protruding and rounded window sills, dentils under the cornice line with smaller strings of dentils under nine pairs of windows on either side of the main entrance and a row of sculpted animal heads (Russian wolfhounds?) above the arched entry.

- Two-dimensional design elements create additional surface patterning, like the keystones above windows, the patterned frieze at the top of the arcade, the light color of the sills which contrast with the surrounding brickwork and the varying depth of the sills, with those under the columns of windows at each end of the elevation and over the central arched opening twice the depth of the others.

7.4.3.2 Other Elevations

Elevation Along The Waterfront

- From the South Boston side of Fort Point Channel, the elevation of another piece of Russia Wharf flanks the vent building site on the left. It also provides the strongest

reference point for the new building since it expresses the architectural character that is typical of the Fort Point Channel Historic District. The closer any new development comes to the waterline on the Boston Edison site, the more relevant this will be.

- Compared to the front elevation, the elevation on the waterfront is less decorated and more uniform. The overall impression is one of a regular grid of evenly spaced rectangular windows set flush into a red-brown brick wall, above rectangular and flush granite sills. This holds true for six of the seven stories. There is no attempt to break down the elevation into three segments as in the front or to mark the transition from one section of the elevation to the next.

FIGURE 7.9

RUSSIA WHARF ATLANTIC AVENUE ELEVATION

470 ATLANTIC AVENUE (HARBOR PLAZA) ELEVATION

FIGURE 7.10

- The exception to this is the 25-30 foot section of wall which wraps around the end of the building from Congress Street, completing the more formal front elevation at a depth two windows in from the street. This echoes the tri-partite elevation of the Atlantic Avenue elevation, with a two stories painted masonry arcade surmounted by four stories of windows with granite keystones and by one story of windows without keystones sitting between the cornice line and the roof line above. The roof line is emphasized by an overhanging copper cornice with dentils beneath. This overhang, along with the granite cornice line, arcade, window treatment and type of brick, all stop abruptly after the second column of windows and give way to the simpler treatment described above. From this point on, the window treatment from one floor to the next remains undifferentiated and the windows on the seventh story stop just below the roof line.

- The overall building height and corresponding cornice and arcade lines are slightly lower on the Congress Street sections of Russia Wharf than on the section fronting Atlantic Avenue (between 8-10 feet lower).

- At the right end of the elevation, a single blackened brick smokestack remains, which protrudes above the roof line.

- A series of loading doors characterize the elevation at ground level.

Rear Elevations - Russia Wharf

A continuous brick wall extends the full length of the site along its southern boundary to a height of about 30 feet. Four separate end wall sections of Russia Wharf rise above this separated by light wells each about 40 foot wide. None of these end walls has openings except for the 540 Atlantic Avenue section where there are two stories of recently-added windows at the top of the building.

470 Atlantic Avenue

A twelve-story building flanks the northern boundary of the Boston Edison site at 470 Atlantic Avenue. It reaches a height of 165 feet, roughly 65 feet higher than Russia Wharf at 540 Atlantic Avenue. Bands of horizontal windows are set flush into the wall facing the vent building site over the full 12 story building height. Occupants of 470 therefore look directly out onto the vent building site.

7.4.4 Building Design Concept

The following section explains the underlying design intentions and the application of design guidelines on which the preliminary design drawings for Vent Building No. 3 have been based.

General Design Criteria

The architectural design concept of Vent Building No. 3 is derived from both the need to respond in a positive way to the immediate neighborhood context and the desire to express the nature of the building function and its relationship to the Central Artery Tunnel.

The building is located at the edge of the downtown Financial District between Atlantic Avenue and the Fort Point Channel. This context creates complex design requirements including the need to consider the appearance of the structure from both the Channel side and the Atlantic Avenue side; the need to relate in a positive way the the historic Russia Wharf building; and the need to adapt the design of the exhaust stack to the architectural context of the immediate neighborhood, which includes several new high rise office buildings.

The building structure is located adjacent to the tunnel, with supply and exhaust ducts entering the building horizontally and then transitioning to a vertical position within the building envelope. The plan of the building is based on the minimum footprint necessary to enclose the tunnel ventilation equipment below grade, allowing for the possibility of future joint development uses above grade. The ground level of the building provides access to the ventilation functions, a loading area, and mechanical shaft space. The remainder of the ground level is available for a future joint development use tenant. High ceiling height has been reserved for a future mezzanine level to increase the desirability of the tenant space and to maintain the existing street pattern established by the arcade of Russia Wharf. Because of the elevation of bedrock, it was found necessary to locate the ventilation electrical equipment at the second level rather than in a fourth sub-basement level. This floor is expressed in the building facades as a piano nobile, reminiscent of similar facade patterns in the immediate neighborhood.

The building is designed to respond to the underlying traditional patterns of the Russia Wharf facade without literal replication of that facade. These patterns are established using modern materials systems, detailed to clearly represent their construction. Patterns of forms addressed by the design include the street level colonnade with mezzanine, the axial entry with silhouette element, and the flat facade fronting Atlantic Avenue. Materials systems include yellow brick with two foot rustications used at south and west facades in response to more utilitarian uses (additional brick graphic patterns may be developed by Section Designer to increase richness of brick walls and exhaust stacks); pink granite used at colonnade elements occurring at north and east facades in response to pedestrian interface.

Examples of modern detailing of traditional forms and materials to be used in this building include the expression of brick as non-loadbearing veneer with metal trim covers at shelf angles and movement joints to match the finish of the window system; granite veneer expressed as non-loadbearing veneer in a "non-gravitational" grid system analogous to the form of the concrete structure underneath; and metal cladding divided into a "non-gravitational" grid related to the module of supply air louvers. The finish of supply air louvers matches the finish of metal panels and metal copings.

The design incorporates an architectural expression of ventilation building functions developed as a counterpoint to the traditional formal patterns discussed above. Exhaust stack terminations follow project-wide standards, but the stack shaft has been clad in granite and brick veneers with metal shelf angle joint covers to better relate to the urban context. The combination of materials together with possibilities for lighting and graphic treatment of exhaust stacks creates an opportunity for rich optical effects which may be developed by the Section Designer. The functional connection of the exhaust stack to the tunnel has been expressed at the east elevation by revealing it penetrating the ground. Supply air grilles follow project-wide standards, creating an iconic form. The structural module is for the most part based on fan modules, but has been mitigated by the formal requirements of the colonnade pattern. A metal cladding system is used as a contrasting material to delineate forms and to create a "virtual transparency" relationship with the other cladding elements.

7.4.5 Basic Architectural Program

This Section defines those architectural program components in Vent Building No. 3 needed to preform its basic CA/T support functions.

7.4.5.1 Program Summary

The primary Vent Building No. 3 program component is the mechanical equipment and building space needed to exhaust tunnel air and provide fresh air to the I-93 tunnel. The "mandatory" CA/T building program includes these additional components:

1) A communications suite which houses equipment for the acquisition and transmissions of local communications and management system data to the central fiber optic communications network; and,

2) A satellite maintenance facility, which provides local maintenance workshops for mobile building maintenance crews, as well as access to the I-93 tunnel by maintenance and emergency personnel.

3) Emergency Platform ES-#6, an outdoor 2 bay-parking spot for a wrecker and a police cruiser with access to call-box type telephone and restroom. ES-#6 provides immediate access to and visual control of the surface roadway, and nearby ramp access to the I-93 NB tunnel. No building space is dedicated to emergency response functions. Personnel in vehicles at this location could use restrooms in the ventilation building.

4) Unassigned (tenant) space is provided at the street level as a mitigation measure to insure an active pedestrian environment at the Atlantic Avenue sidewalk. The finishing of this area is to be provided by the future tenant. A high ceiling is provided at this level to allow for future construction of a mezzanine floor by the tenant. An area truck loading and trash storage is located adjacent to service vehicle access.

The table below summarizes the approximate areas required for the building components. The following report section includes architectural programs for each of the three major components of Vent Building No. 6.

Table 7.2 Architectural Program Summary

Building Components	Net Square Feet
Ventilation Component	121,000
Communications Component	2,000
Maintenance Component	2,000
Tenant Space	13,200
TOTAL NET SQUARE FEET	138,200
X 1.4 gross to net factor	
TOTAL GROSS SQUARE FEET	193,480

7.4.5.2 Ventilation Component

Purpose

This building is one of six facilities providing mechanical ventilation for CA/T tunnels. It serves Ventilation Sector 2, the I-93 Northbound and Southbound tunnel from Congress St./Summer St. to State Street. Major functions are to maintain safe in-tunnel

air quality and to provide for effective control of smoke and heat in the event of an in-tunnel fire. Vent Building No. 3 serves as a point of access/egress to the tunnel for both maintenance and emergency personnel.

The building is to be located adjacent to the tunnel structure, which creates particular dimensional requirements for duct transitions and access. Vent Building No. 3 will have 9 supply fans and 14 exhaust fans. Exhaust stacks are to be 250' high above grade.

Primary Activities

1) Supply fresh air to the tunnel from outside air intake louvers through supply air fans and supply air duct connections below the roadway level.

2) Exhaust stale air and combustion products from the tunnel through exhaust air ducts above the tunnel ceiling to exhaust air fans and discharge air stacks.

3) Regulate air pressure in the tunnel in order to prevent the spread of smoke and heat in the event of a fire.

4) Support tunnel operations with communications equipment and oil/water separators for tunnel drainage system.

5) Provide electrical and mechanical service for above functions.

6) Provide access/egress to the I-93 tunnel for maintenance and emergency personnel.

7) Maintain vent building machinery. Equipment hatches, trolley beams, and overhead service doors are provided for access, equipment removal, and installation.

8) Personnel restroom and washing activities.

9) Loading/service/controlled access to all CA/T building program components.

Staffing and Users

No permanent, on-site staff. Maintenance staff for vent building, communications equipment, ducts and tunnel; emergency response crews during tunnel emergencies; no public access.

Ventilation Spaces and Programmatic Requirements

Fan and duct layouts are provided by the preliminary design. This program identifies the primary spaces and their architectural characteristics.

Supply Air Functions

1) Supply Air Room - large unheated open space (plenum) holding all (9) supply air fans. Fresh air is drawn through the outside air intake louvers on exterior wall, thereof this room should be located on outside wall or have a large ducted shaft from louvers to it. This room should have concrete floors, floor drains, pressure hose connection and unfinished ceiling since the room needs to be washable.

   Fan foundation size in plan is about 16' wide and 20' long. Typical supply fan plus circulation module is 40' long, 26' wide, 25' high, resulting in spacing of fans 26' on center. The 40' length provides about 20' horizontal fan access clearance. Standard 3' clearance for fan coupling is required.

2) Supply Air Ducts - rectangular concrete ducts which take air from supply fan to the tunnel supply air plenum below the roadway surface. One duct is needed per fan. Standard interior dimension is 12' x 10'.

Exhaust Air Functions

3) Exhaust Air Fans - 14 are required for Vent Building No. 3. Each fan is in a separate enclosed plenum to which exhaust air from the tunnel is drawn through exhaust air ducts. A damper in each exhaust air plenum controls the flow. The fan feeds the air up the stack. Typical exhaust air plenum dimension is 37' x 27' and 25' high, with a motor that protrudes into corridor space. Each plenum has a steel plate removable wall (supplied in Contract D020B) for fan installation and removal.

4) Exhaust air ducts are concrete rectangles - The transition area between duct and shaft must meet width and curve radii criteria established by the D020B SDC.

5) Exhaust air stacks (1 per exhaust fan) - have standard interior dimensions 10' x 13'. Stack height is determined by two factors: height needed to disperse exhaust air and the height of adjacent buildings. The height of Vent Building No. 3 stacks has been determined to be 250'.

Mechanical/Electrical Support Areas

6) Electrical Equipment - approximately room is 10,300 - 11,000 s.f.).

7) Emergency Generator - locate near UPS room and electrical room, away from supply air louvers due to fumes and communications due to noise and vibration.

8) Battery Room/Uninterrupted Power Supply (U.P.S.) - contains equipment which protects vent building equipment from fluctuations in power supply. Contains battery acids and fumes, requires forced air exhaust and therefore exterior wall location away from supply air intake louvers. Need eye wash basins, hose bib for washing down walls and floors, floor drains. Minimum size is 600 s.f. A second U.P.S. is needed for the communications equipment; these can be combined in a single room of about 1000 s.f.

9) Fan Control Rooms - solid state electronic equipment that starts and regulates speed of fans. Need 1 room for each floor where fans are located, therefore 2 are needed for Vent Building No. 3.

Tunnel Support Areas

10) Tunnel access - one stair is to be provided for maintenance and emergency access to the CA-NB tunnel.

Building Support

13) Janitor - typical 40 - 100 s.f., contains slop sink and mop receptacle, water service, shelving for janitorial supplies, space for storing vacuum cleaner and other implements.

14) Lobby/Entry - controlled entry for CA/T maintenance, emergency response personnel and communications equipment technicians only.

15) Elevators and Stairs - part of controlled access circulation. Need to be close to Maintenance and Communications components, close to loading docks for convenience in bringing in smaller parts to building.

16) Staff toilets - male and female, accessible to disabled. Typical size: 90" x 72" for stall with sink, 36" x 60" for roll-in shower results in 60 s.f. per sex, minimum 120 s.f. total.

17) Fan Service Access - a monorail track and crane (part of D020B) are needed on each floor that has fans or electrical equipment for installation and removal of large pieces of equipment. A "spur" of the track is provided to each fan. The supply air shaft is to be located so that equipment on all building levels can be moved to and from the loading dock. Fan hatches are 16' x 20', electrical equipment hatches are 9' x 16'. Interior circulation corridors should be designed for fan turning radii, about 26' wide. Minimum clear corridor between protruding motors on exhaust fan plenums is 16'.

    The loading area can be outside, with fans loaded from the side of a flat-bed truck. Door height should be adequate for fan height (25') plus floor height of truck bed (4'0"), with roll down doors.

18) Off street loading bays - for site efficiency, loading dock should be designed to serve both vent building, maintenance and joint development functions (if approved). An enclosed dock with 3 bays is required, with controlled access to CA/T ventilation building areas. Bay width should be 10', length should be 40', assuming a straight body flat bed truck, 35' long, for equipment delivery & removal.

7.4.5.3 Communications Component

Purpose and Primary Activities

The communications system is described in the Integrated Project Control System (IPCS) Concept Report. The Communications program component in Vent Building No. 3 provides rooms for equipment and cabling required to support transmission of voice and data from various sources to the central communications system which feeds into the Operations Control Center. These are:

1. Traffic Surveillance and Control Systems (TSCS), which detects traffic flow blockages via sensors and Closed Circuit TV and controls traffic flow via metering lights and variable message signs;

2. Facility Control System which includes fire detection, security, electrical, building and tunnel ventilation (formerly called Supervisory Control and Data Acquisition "SCADA" system);

3. Telephone

4. Radio; and

5. Other input sources such as service phones in roadway sections, agency communications interfaces, etc.

The communications suite should be located as near to the tunnel wall as possible to minimize cabling distances. It should be near staff entry/elevators and maintenance program area to allow joint use of toilets and service/delivery access.

Staff & Users

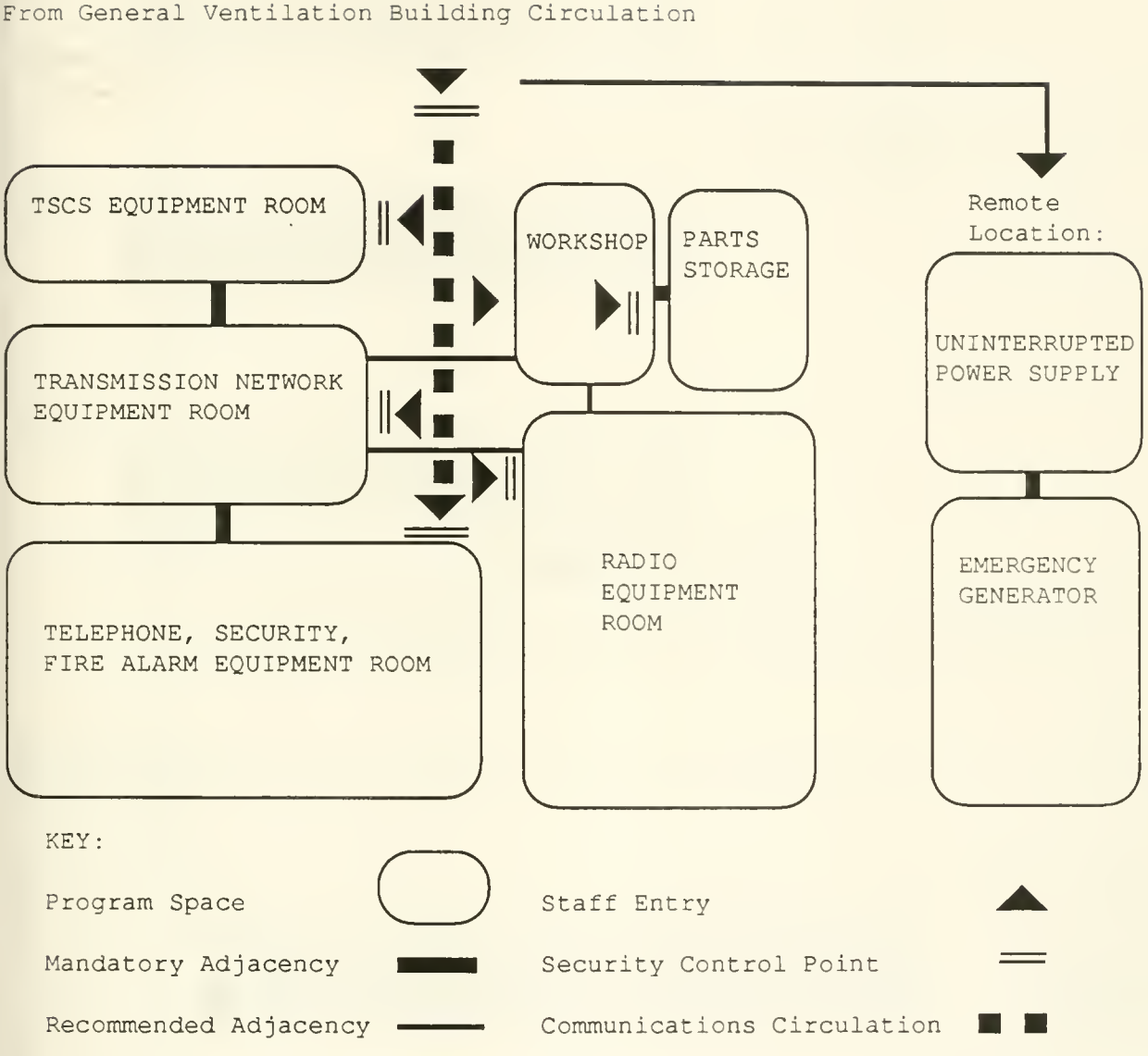
Four main types of equipment technicians: fiber optic technicians, radio technicians, telephone technician, and fire & security alarm technician. Separate rooms are provided to prevent human error through technicians from working on equipment which they are not qualified to work on, and to improve security.

Table 7.3: Ventilation Component Space Square Footage

COMPONENT SPACES	AREA S.F
SUPPLY AIR FUNCTIONS	
1. Supply Air Rooms	27,200
2. Supply Air Ducts	6,200
Subtotal	33,400
EXHAUST AIR FUNCTIONS	
3. Exhaust Air Plenums	15,900
4. Exhaust Air Ducts	29,800
Subtotal	45,700
MECHANICAL/ELECTRICAL SUPPORT AREAS	
5. Electrical Equipment Room	10,300
6. Emergency Generator	700
7. Battery Room/Uninterrupted Power Supply (U.P.S.)	1,600
8. Control Rooms (2)	4,600
9. Boiler Room	3,400
Subtotal	20,600
TUNNEL SUPPORT AREAS	
10. Oil/Water Separator	3,440
11. Tunnel Roadway Access Stairs	260
Subtotal	3,700
BUILDING SUPPORT (for all components in Vent Building No. 3)	
12. Janitor	100
13. Lobby/Entry	150
14. Elevators and Stairs	2,500
15. Staff Toilets M/F	150
16. Mechanical/Electrical Room	1,000
17. Off-street Loading	500
UNASSIGNABLE	13,200
N.S.F. TOTAL	121,000

Table 7.4: Communications Space Square Footages

COMMUNICATIONS COMPONENT SPACES	AREA S.F
1. Transmission Network Equipment Room	200
2. Traffic Surveillance & Control System Room	150
3. Telephone/Security/Fire Alarm Equipment Room	400
4. Radio Equipment Room	450
5. Electronic Workshop	100
6. Spare Parts Room	100
N.S.F. TOTAL	1,600



Communications Suite Adjacencies

FIGURE 7.11

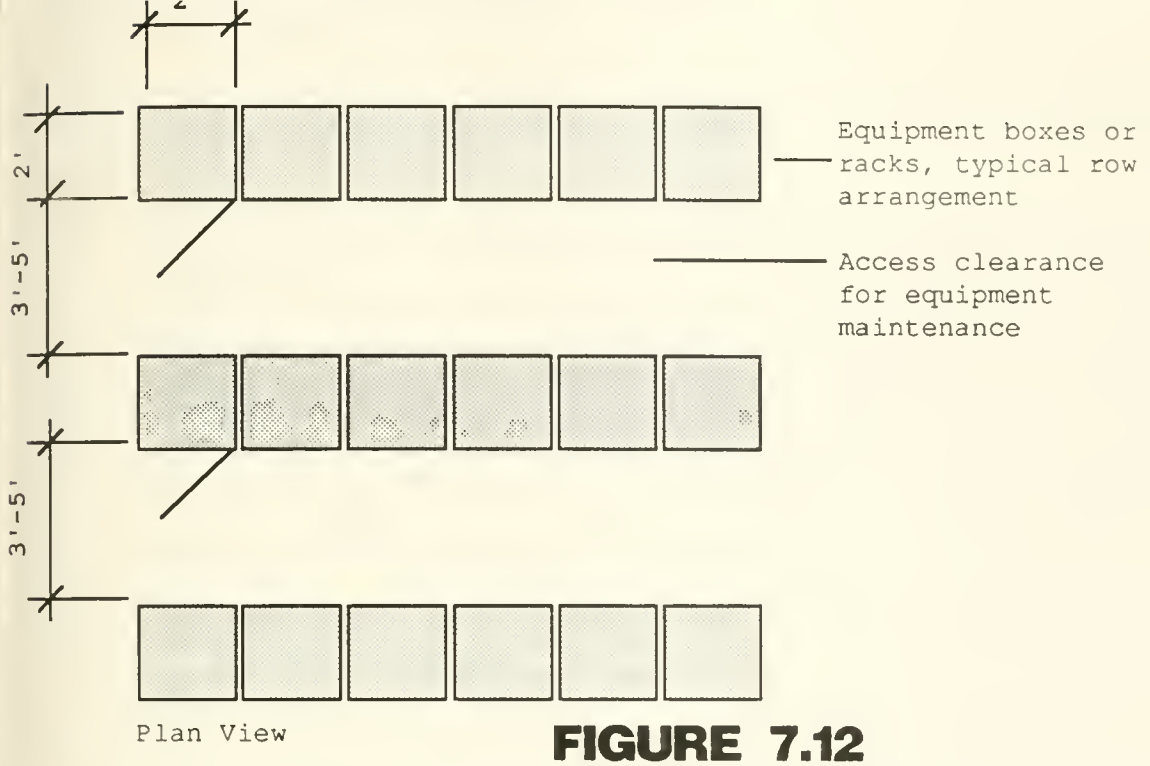


FIGURE 7.12

Box or Rack Equipment Rooms Critical Dimensions (Appplicable to Transmission Network Equipment and Radio Equipment Rooms).

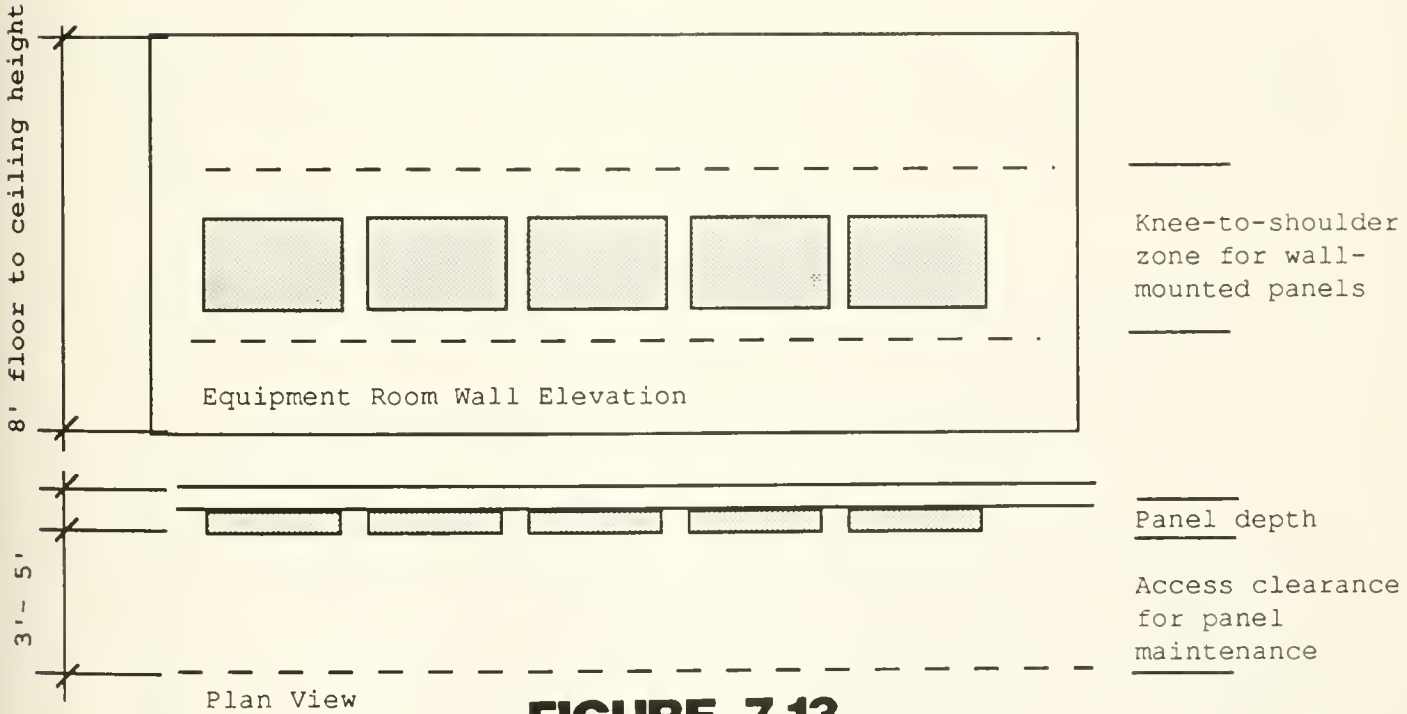


FIGURE 7.13

Mounted Panel Equipment Rooms Critical Dimensions (Applicable to TSCS Equipment and Telephone, Security and Fire Alarm Equipment Rooms)

Note: For general information only - unit quantities, design and layout to be determined by IPCS SDC.

Communications Spaces Description

Note: dimensions are approximate, and do not constitute design direction. These are given to generally explain equipment layouts and room sizing only.

1. Transmission Network Equipment Room - Distribution point which contains the interface equipment that connects the central communications cabling system to the Remote Terminal Units (RTUs) in area, allows data movement from local area to central communications system. Consists of 2 redundant systems, connected with switching equipment, to provide "hot stand-by" capability in event one system fails. Equipment boxes and racks sit in rows on the floor and have approximate standard dimensions 2' x 2' footprint, height range of 4 - 7' with 5' clearance required between rows (see Figure 7.12: Boxes or Rack Equipment Rooms Critical Dimensions).

   A cable chase containing main central communications cables comes up to the transmission network equipment room from main tunnel communications conduit, making its location close to the tunnel roof necessary to minimize cable length. Because this room is the central point for transmission of all data to and from the other equipment rooms, it should be located in the center of the communications suite with the other equipment rooms around it to minimize cabling lengths. (See Figure 7.11: Communications Suite Adjacencies).

2. Telephone, Security, Fire Alarm Equipment Room - houses local controller panels or boxes mounted between "knee to shoulder height" on the wall (approximate size is 6" x 2' x 3') which pick up data from the lines and sensors throughout the local area, and transmit them to the transmission network equipment. (See Figure 7.13: Mounted Panel Equipment Rooms Critical Dimensions)

3. Traffic Surveillance and Control System Equipment Room - contains local controllers for some traffic equipment/devices in tunnel roadway area which pick up data and transmit it to the Remote Terminal Unit. Equipment is similar in dimension to other communications rooms - local controller panels or boxes mounted between "knee to shoulder height" on the wall (approximate 6" x 2' x 3') or equipment racks.

4. Radio Equipment Room - radio signals enter the building via an antenna cable in the tunnel roof, and are transmitted into the central fiber optic network. Needs to be located close to the tunnel roof to minimize cable distances, and away from fan rooms or other equipment which generates noise, as this could interfere with sensitive receivers. Equipment consists of receivers and transmitters and multiplexing equipment with basic unit dimensional requirement as transmission network equipment (2' x 2' floor footprint, 4 - 7' height, lined up back-to-back in rows, with 5' clearance required between rows).

5. Electronic Workshop - room with workbench 36" deep height appropriate for technicians on high stools, at least 6' long, used for panel testing and service (11" x 17" likely largest size), small equipment = PC, volt meters, oscilloscopes. Benches to be purchased, not custom designed.

6. Spare Parts Room - to store boards & components, floor to ceiling metal cabinets, with locks, protected from dust, moisture, movable shelves 12" and 18" deep.

7. Uninterrupted Power Supply (UPS) Room - this space is to be combined with the U.P.S. room shown in the Ventilation Component Table. It contains batteries and equipment that isolate the communications equipment from the vent building electrical power distribution system, protecting the communications equipment from random load fluctuations and switching. Equipment converts (rectifies) AC current to DC for the batteries, and reconverts (inverts) DC back to AC for continuous flow of power to communications equipment. If the power supply to the building is interrupted, UPS equipment supplies battery power until the generator is functioning.

   The batteries generate toxic and flammable hydrogen gases requiring a forced air ventilation system. Acid resistant concrete floors with sump to collect spilled battery acid for disposal as hazardous waste are required. Cold water supply is needed for hose bib to wash down walls and floors, eye wash stations and wet sink.

Communications Suite Technical Requirements (See Project Design Criteria for further information).

1. Ceiling cable trays will be required for the transmission network equipment room, telephone/security/fire alarm equipment room, traffic surveillance control system equipment room, radio equipment room.

2. Ample cable ducts (approx. 2' x 4') are required from communications ducts in tunnels to transmission network equipment room and radio equipment room.

3. Equipment rooms (transmission network equipment room, telephone/security/fire alarm equipment room, traffic surveillance control system equipment room, radio equipment room) may need electromagnetic interference shielding.

4. HVAC: Active multiplex and transistorized equipment is sensitive to heat, humidity and dirt. In order of sensitive, the fiber room is most sensitive, telephone room next, radio room next. Positive ventilation is needed for the entire communications suite, with exception of negative pressure for UPS room to exhaust gases. HVAC range is 32 - 120 degrees, with 65-84 degrees optimum. Air should be filtered to eliminate dust and dirt and humidity controlled to 95% or less, non condensing.

5. Finishes: sealed concrete floors, exposed ceiling (see Project Design Criteria, Architectural section).

6. Security: controlled access to communications Suite limited to Communications technicians. Within suite access to each equipment room controlled.

7.4.5.4 Maintenance Facility Component

Purpose

The maintenance facility network serves four main elements of the CA/T: the highway, buildings, landscaping and vehicles. The network consists of:

1. a central roadway maintenance facility, proposed to be located in South Boston, from which personnel are dispatched to satellite facilities and work assignments;

2. satellite facilities, located throughout the system, which provide a local base of operations for crews and staging areas for emergencies and snow storms; and,

3. Unstaffed building maintenance mechanical and electrical workshops, of which this is one, which provide space for personnel to perform minor maintenance and repair tasks close to the highway and its buildings. The maintenance component of this program will support building repair and maintenance tasks related to the nearby tunnel as well as the maintenance of the ventilation equipment.

Primary Activities

1. Indoor parking of 2 maintenance vehicles (pick-ups or utility vans).

2. Minor repair of mechanical and electrical equipment.

3. Limited storage of building and vehicle maintenance supplies and parts.

Staffing and Users

No full-time occupancy; mobile maintenance personnel will be dispatched to this location as required.

Table 7.5: Maintenance Space Square Footage

BUILDING COMPONENT PROGRAM

Maintenance Crew Support

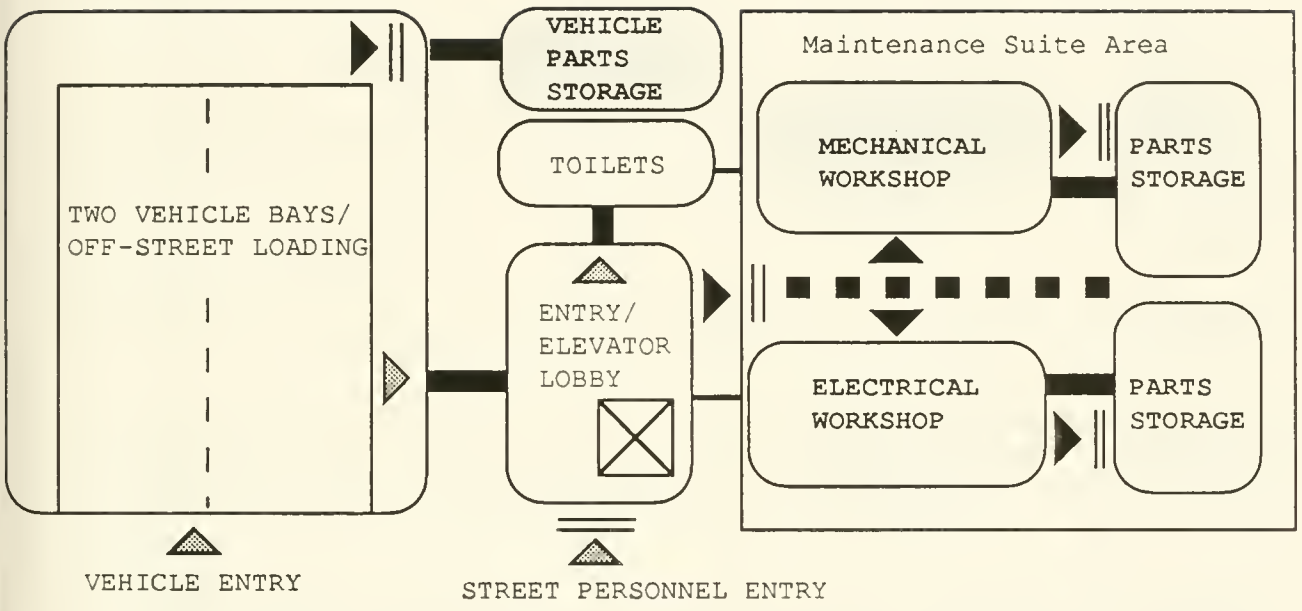
MW 1.	Day Room - 4 persons @ 24NSF/person	96	
MW 2.	Toilet - (1 toilet, 1 lavatory)	50	
			146 NSF
Total Net Square Feet			146 NSF
Total Gross Square Feet (G:N = 1.6)			235 GSF

GARAGE COMPONENT PROGRAM

GMW 1.	Mechanical Workshop	400	
GMW 2.	Electrical Workshop	400	
GMW 3.	Mechanical/Electrical Storage	200	
			1000 NSF
Total Net Square Fee			1000 NSF
Total Gross Square Feet (G:N = 1.4)			1400 GSF
Combined Total Gross Square Feet			1635 GSF

Site Component

SMW 1.	Parking for van with trailer 20 x 20	400	
-			400 NSF



KEY:

Maintenance Program Space

Shared Building Support Space

Mandatory Adjacency

Recommended Adjacency

CA/T Maintenance Staff Only Access

All Building Personnel Access

Security Control Point

Maintenance Area Circulation

Maintenance Component Spatial Relationship

FIGURE 7.14

Design Requirements

1. Garage bays must be designed to accommodate vehicle length, width, height and turning radii. Utility Vans = 15' to 20' long, 7' wide, 7' height, 25' turning radii. Bay sized to allow circulation around vehicles and indoor loading/unloading, therefore 10' by 25'. Garage doors to be rolldown type.

2. Emergency vehicle access: fire trucks have 48' turning radius, may enter site with 30 - 40' curb radius and back out.

3. Bays must be equipped with floor drains and oil/grease separators; floors must be sloped to drain.

4. Automobile exhaust must not be able to move from vehicle bays into building.

5. Vehicle bays must be near elevators for moving of supplies from vans to other building levels.

6. Mechanical Workshops: work area with bench, power tools (one drill press, vise, grinders, saws, pipe cutters), first aid equipment, fire extinguishers, portable hoist, pump, hand tools, cutting torch and welding equipment.

7. Electrical Workshops: work area with bench, power tools (one drill press, vise, grinders, saws, pipe cutters), testing equipment and meters, first aid kit and fire extinguishers.

8. Parts Storage: lockable cabinets, movable shelves.

7.4.6 Code Analysis

The following analysis outlines current assumptions concerning the State Building Code requirements as they may relate to Ventilation Building No. 3. The Section Designer is responsible for reviewing and verifying all code requirements, including other applicable regulations referenced in the Project Design Criteria. Code requirements that follow fall under the following headings:

1. Primary use.
2. Secondary uses.
3. Types of construction.
4. Allowable areas and heights.
5. Fire separations.
6. Exterior wall protection.
7. Fire resistance.
8. Interior finish.
9. Means of egress.
10. Handicapped access.
11. Energy use performance.

1. Primary Use Groups

The tunnel ventilation function of this building is not specifically addressed in the code. Assumption that tunnel ventilation function is closest to Group F-1 per 312.1 Doubtful Use Classification: "When a building or structure is proposed for a use not specifically provided for in this code or the classification is doubtful, such building or structure shall be included in the use group which it most nearly resembles in respect to the existing or proposed life and fire hazard, and it shall be so classified by the building official." Assume 305.2 Use Group F-1, Moderate Hazard factory and Industrial Uses most nearly similar to Boiler Works and Power Houses per 312.1. "Factory and industrial uses which are not otherwise classified as low hazard Use Group F-2 shall be classified as moderate hazard factory and industrial Use Group F-1".

308.0 Use Group M, Mercantile Uses assumed future use for ground floor tenant space. This use group could change depending on the specific nature of the business of future tenant.

2. Secondary Uses

310.2 Use Group S-1 Moderate Hazard Storage Uses for motor vehicle storage at loading dock area, less than 10% of building area of F-1 uses.

3. Types of Construction

402.1 Construction Classification:

Assume Type 1B Construction with fire resistance ratings per Table 401 as follows:

Exterior loadbearing walls:	3 hr.
Exterior non-loadbearing walls:	(see fire resistance 906.2)
Fire walls and party walls	3 hr.
Fire separation assemblies	(see Fire Separations Table 902)
Smoke barriers	1 hr.
Fire enclosures at exits, exit hallways, and stairs	2 hr.
Shafts and elevator hoistway	2 hr.
Exit access corridor	1 hr.
Tenant space separations	1 hr.
Other non-bearing partitions	0 hr.
Interior bearing walls and columns	3 hr.
Interior bearing walls and columns bearing 1 floor only	2 hr.
Structural members supporting walls	2 hr.
Beams and floor construction	2 hr.
Roof construction and beams	1-1/2 hr.

4. Allowable Areas and Heights

305.0 General area and height limitations per Table 305;

Group F-1, Type 1B Construction: unlimited feet high, unlimited SF per floor.

Group M, Type 1B Construction: unlimited feet high, unlimited SF per floor.

Group S-1 (ancillary use of F-1, less than 10% of floor area).

501.1.1 Special Industrial use exempts ventilation function of building from height and area limitations of Table 305, because of need to accommodate special machinery (large fan units).

Canopy may require a variance from setback and height regulations of 510.4.

5. Fire Separations

Fire separations for occupancy changes:

Assume nonseparated uses per 313.1 Nonseparated Uses for Mixed Occupancy. "The required building type of construction shall be determined according to the use of the building which has the more restrictive height and area limitations. The most restrictive applicable provisions of Article 10 shall apply to the nonseparated uses. A fire separation assembly is not required between uses, however, fire separation assemblies shall be provided as required by other sections of the code. Tenant separations shall be provided as required in Table 401."

Separation between Use Group S-1 and Use Group F-1 not required per 313.1.4 (supplemental uses less than 10% of building area do not require fire separation for change of use).

6. Exterior Wall Openings Protection

Variance and/or easement may be required for zero clearance of supply air louvers at rear property line. Per Table 906.3 neither protected nor unprotected openings are allowed with less than 3 of fire separation as in rear yard. With over 30'-0" fire separation at side yards, unprotected openings are unlimited in area.

7. Fire Resistance

902.0 Fire Hazard Classification

Group F-1: 3 hours
Group M: 3 hours
Group S-1: 3 hours

Exterior wall fire resistance rating requirements per Table 906.2:

0 - 5 ft	3 hours
5 - 10 ft	2 hours
10 - 15 ft	1 hour
15 - 30 ft	0 hours
greater 30 ft	0 hours

Fire suppression required per 1002.0.

Standpipe system required per 1012.2.4

8. Interior Finish

Flame spread classification requirements for interior finish materials per Table 922.5:

Group	Vert. Exits	Exits & Corridors	Rooms & Enclosed Spaces
F-1	I	II	III
M	I	II	III
S-1	II	II	III

9. Means of Egress

Occupancy Loads per Table 806:

Industrial (vent bldg.) areas:	100 SF gross/occupant
Storage areas:	300 SF gross/occupant
Mechanical equipment areas:	300 SF gross/occupant
Storage areas:	300 SF gross/occupant
Retail areas, ground floor:	30 SF gross/occupant

Areas of toilet rooms omitted per 606.6 - non-simultaneous occupancy.

Exit locations per 807.4.1: 2 exits located 1/4 diagonal dimension of building area with fire suppression system. 1/2 diagonal distance without fire suppression.

Maximum length of exitway access travel per Table 807:

Factory Uses:	200 ft (250 ft with fire suppression)
Storage Uses:	200 ft (250 ft with fire suppression)
Mercantile Uses:	200 ft (250 ft with fire suppression)

Capacity of egress elements per Table 808:

Minimum corridor width per 810.3: 44 inches for greater than 50 occupants, 36 inches for less than 50 occupants

Stairway width: 0.3 inches per occupant without fire suppression, 0.2 inches per occupant with fire suppression.

Corridor, door, and ramp width: 0.2 inches per occupant without fire suppression, 0.15 inches per occupant with fire suppression.

Minimum of 2 exits per Table 809.2. Verify exemption of Pump Station area and mechanical duct spaces at Sublevel 3.

Maximum dead end corridor length of 20'-0" per Table 809.2. Verify exemption of fan room accessway (to be considered as one room).

Interior exitway stairways:

Minimum dimensions:

Width: 44 inches, 36 inches if under 30 occupants.

Headroom:	6 feet 8 inches
Landing width:	width of stair
Vertical rise:	maximum 12 feet between landings.
Maximum riser:	7 inches.
Minimum tread:	11 inches.
Handrail height:	between 30 and 38 inches between 30 and 42 at guardrails.
Handrail extension:	12 inches beyond top step, 12 inches plus tread width at bottom.
Handrail projection:	maximum 3-1/2 inches into stair.
Guardrail height:	minimum 42 inches (828.0)
Guardrail openings:	maximum 6 inches diameter, 14 at Group F-1 use areas (827.0)
Access to Roof:	Per 817.1, Stairway or trap door to roof required for buildings over 3 stories high (not required for Vent Building No. 3).
Exit Signs:	Per 823.1, Illuminated exit signs required for buildings with over 50 occupants.
Means of Egress Lighting:	Per 824.1, Emergency lighting system

Boiler rooms shall have 2 egress doorways if area is over 500 SF and equipment exceeds 400,000 BTU input capacity.

10. Handicapped Access

521 CMR Regulations of Massachusetts Architectural Access Board: Requires all parts of the building to be accessible to the disabled.

11. Energy Use Performance

Section 3100.00 requirements for insulation of inhabited spaces applies to portions of this building.

7.4.7 Outline Specifications

Concrete

Architectural Cast-In-Place Concrete (03300)

Exposed cast-in-place architectural concrete walls and slabs. Concrete hardener/dust proofing at all exposed slabs and decks.

Masonry

Unit Masonry (04200)

Brick masonry units in non-loadbearing ventilated rainscreen/cavity wall construction, and reinforced concrete masonry units in non-loadbearing construction.

Facing brick: Grade SW (Severe Weathering), Type FBX facing brick per ASTM C 216. Smooth texture in norman size. Color per project sample.

Concrete Masonry Units: Grade N (general use), unless otherwise noted.

Mortar: Portland cement mortar per referenced standards.

Masonry accessories: Stainless steel ties, anchoring devices, and inserts. Ties to allow for vertical and horizontal movement. Full head joint polypropylene co-polymer weep-hole insert.

Concealed flashings: Stainless steel mechanically keyed interlocking flashings.

Insulation: 2" thick extruded polystyrene insulation.

Aluminum shelf angle and movement joint covers: Match metal siding finish.

Brick masonry units in non-loadbearing cavity wall construction, and reinforced concrete masonry units in bearing and non-loadbearing construction.

Stone (04400)

"Milford Pink" granite veneer panel with stainless steel ties and anchoring devices.

Granite veneer panel exterior wall cladding.

Metals

Structural steel (05120): Tube steel canopy support. Shop prime with inorganic zinc system.

Metal fabrications (05500): The following metal fabrications may be required:

Ladders and safety cages,
Pipe racks,
Rough hardware,
Nosings,
Loose bearing and leveling plates,
Stack termination structure,
Louver support structure,
Galvanized steel masonry shelf angles.

Steel Stairs (05510)

Steel stairs and railings for interior use.

Stringers:	Steel open channel,
Headers:	Steel channel,
Treads:	Steel tread plate at mechanical areas, steel frame and pan with concrete fill, and resilient non-slip tread at office and other habitable areas.
Nosings:	Formed plate for mechanical areas, resilient nosing at office and other habitable areas.
Risers:	Steel plate
Platforms:	Steel tread plate at mechanical areas, steel frame and pan with concrete fill and resilient floor at office and other habitable areas.
Soffits:	Exposed structure unless otherwise noted.
Railings:	1-1/2" diameter steel.
Newels:	Rectangular steel tube.

Thermal and Moisture

Membrane Waterproofing (07115)

Provide re-sealable membrane waterproofing at foundation walls and floor slabs where indicated on drawings.

Traffic Topping (07570)

Fluid-applied, membrane type, elastomeric, coating for supply air fan room floors.

Preformed Metal Siding (07410)

Aluminum preformed non-insulated siding with "rainscreen" ventilated, self-draining open-joint (dry joint) system.

Single Ply Membrane Roofing (07530)

Fully adhered EDPM roofing system with gravel ballast.

Flashing and Sheet Metal (07600)

Metal counter flashing and base flashing; metal wall flashing and expansion joints; built in metal valleys, gutters, and scuppers, gutters and downspouts; exposed metal trim and fascia units; miscellaneous sheet metal accessories.

Doors and Windows

Metal Doors and Frames (08100)

Hollow metal doors and frames at locations indicated on drawings.

Interior Doors:	SDI-100, Grade II, heavy duty, Model 1, minimum 18-gauge faces.
Exterior Doors:	SDI-100, Grade III, extra heavy duty, Model 2, minimum 16-gauge faces.
Metal Frames:	Minimum 14-gauge cold-rolled furniture steel fabricated with mitered and welded corners. No knocked-down frames will be allowed unless otherwise noted.

Overhead Coiling Doors (08330)

Interior and exterior insulated and non-insulated overhead coiling aluminum and steel doors.

Sectional Overhead Doors (08360)

Industrial quality glazed aluminum sectional overhead doors as indicated on drawings.

Aluminum Windows, Storefront, and Entry Doors (08520)

Fixed sash and storefront systems, operable windows, and entrance doors as indicated on drawings.

Fixed sash & storefront:	Isoglaze 450T" 2-1/4" x 4-1/2" framing system with integral Fluoropolymer Paint coating in custom color, conforming to AAMA 605.2. Provide expansion head tracks at areas likely to be subject to excessive structural deflection due to snow loads or floor loads on adjacent structure.
Operable sash:	Sealair 8225T Isolock" 2-1/4" frame top hinged windows with integral thermal break designed for 1" insulated glazing. Flouropolymer Paint coating in custom color, conforming to AAMA 605.2. Clear white bronze hardware. Provide manufacturer's insect screens.
Entrance doors:	"500 Wide Stile" Swing Doors manufactured by Kawneer Company, Inc., or approved equal. Flouropolymer Paint coating in custom color, conforming to AAMA 605.2. Integral panic devices

where required. "Architects Classic" US32 polished stainless steel 1" diameter bent bar push/pull or approved equal.

Hardware (08700)

Furnishing and installation of finish hardware.

Glazing (08800)

Glass and glazing not specified as "preglazed", including window units, construction, entrances, and other doors, and glazing sealants.

Finishes

Gypsum Board Systems (09250)

Gypsum Drywall work, including steel suspension systems for screwable steel stud partition framing, screwable "Zee" wall furring, steel suspension systems for interior gypsum wallboard ceilings, miscellaneous steel stud bracing, bracketing and framing at suspended ceiling edgings, fascias and skylight walls, and gypsum wallboard finishes complete.

Acoustical Ceilings (09510)

Acoustical Panel Ceilings (exposed suspension).

Panels:

Lay-in: Type III, Form 1, patterns "d", "f", "k", White, LR 2, Grade NRC 75, STC 35 - 39, square-edged, 3/4" x 24" x 48".

Resilient Flooring and Base (09650)

Resilient Flooring and related items, including preparation of concrete floor slabs and fills, Raised Profile Rubber Tile, Vinyl Composition Tile, Vinyl Sheet, Vinyl Wall Base, Rubber Stair Treads, Risers and Skirtings.

Painting (09900)

Field-applied paint to items and surfaces including surface preparation, prime coats and topcoats.

Specialties

Toilet Partitions (10150)

Hollow metal toilet partitions and screens.

Louvers and Vents (10200)

Custom stationary formed sheet aluminum supply air louvers for ventilation buildings, and standard stationary extruded aluminum louvers for non-tunnel ventilation uses.

Identifying Devices (10400)

Exterior cast metal plaques, exterior metal letters and numbers, and interior panel signs.

Toilet and Bath Accessories (10800)

Metal toilet accessories and related items.

Equipment

Loading Dock Equipment (11160)

Laminated rubber or steel dock bumpers and hydraulic dock lifts.

Conveying Systems

Elevators (14200)

Manufacturer's standard pre-engineered elevator system for passenger and freight, electric traction elevator. 6000 pound capacity. Sliding passenger doors. Controls to comply with State Handicapped Access Code.

Crane Equipment (14500)

Monorail Crane system as required for moving fan units and heavy equipment, designed by Contract D020B. Coordinate for connections and structural loading.

7.5 Landscape Architecture

7.5.1 Introduction

The scope of Landscape Architecture in this section design contract includes design for three conditions:

a. Construction period pedestrian enhancement and protection;

b. Temporary landscapes related to the architectural elements occurring at the surface zones which include ramps, portals, boat section/retaining walls, tunnel headhouses, sidewalks and streets;

c. Backfilling, grading, seeding, asphalt curbs, and asphalt walks and lighting. This will be the condition in which the surface is left at the conclusion of the D017A contract.

7.5.2 Construction Period Pedestrian Protection

The provision of a safe and clean pedestrian environment during the construction period is a priority, to be accomplished by mitigating to the extent possible the negative effects of construction activity, and by providing continuous, direct, protected pedestrian walkways and crossings throughout the contract limits. See Section 7.3.5 above. CA/T pedestrian environments will be supplemented by construction site perimeter fencing, barriers, and signs which are designed as part of a system, with common materials, colors, forms and graphics. Special long-term construction period urban space development is proposed at selected locations to form "gateways" for major pedestrian crossings and sites for construction period art installations.

As tunnel construction proceeds, backfilling should be carried out wherever possible to facilitate the temporary landscape development in order to mitigate the appearance of adjacent construction activity.

High Priority Pedestrian Crossing Zones

Pedestrian travel is to be maintained as close to normal routes, with as little interruption as possible throughout the construction area and time period. Access to existing businesses, residences, and historic attractions has the highest priority, particularly for tourists who may have difficulty finding their way. Extremely high volumes of pedestrian traffic are typical of most crossings within the project area in Section D017A. Pedestrian traffic at selected locations within the downtown was counted, analyzed and mapped in August 1989 (see Draft Central Artery Pedestrian Analysis, March 31, 1990, by Boston Affiliates. (See also reports by Vanesse Hangen Brustlin prepared for BRA and by Cambridge Systematics Inc. prepared for B/PB which record the results of pedestrian counts carried out in July and August 1990). Heaviest pedestrian traffic occurs during the morning and evening rush hours year round and during the lunch hour in warmer weather months. Tourists account for the majority of traffic volumes at the Walk to the Sea (Faneuil Hall Marketplace to Waterfront Park) and State Street (Aquarium MBTA/Marriott Hotel to historic State House/Faneuil Hall Marketplace).

7.5.3 Vent Building No. 3 Site Program and Design Guidelines

Site Limits

The Boston Edison Substation, Russia Wharf, and the Harbor Plaza (470 Atlantic Avenue) will form the east, south and north (respectively) limits of the site (see Urban Design Map No. 4). Ventilation Building No. 3 will occupy the westerly edge of the site, aligning the façade with those of the buildings on Atlantic Avenue, providing a continuity of street edge at the sidewalk, which will be approximately 12 feet in width.

Access easements will be provided as follows:

a. a 30' easement for the Boston Edison substation between Vent Building No. 3 and Russia Wharf;
b. a 45' access easement between the Vent Building No. 3 and the Harbor Plaza Building.

Program Assumptions

The Boston Edison Company will continue to occupy the portion of the site that is east of the Vent Building. The only required change to the Boston Edison facility required is the relocation of the power line on the north side of the site.

Emergency Platform No. 6, providing peak traffic period parking for a tow truck and a police cruiser (2 - 10'x20' spaces), will be accommodated on the site within the easements described above, adjacent to Vent Building No. 3. The parking spaces will have visual contact with and immediate access to Atlantic Avenue/I-93 ramps and to restrooms and telephone as described in 7.4.5 Basic Architectural Program.

No parking will be provided on the site, although the option exists to lease spaces from the Boston Edison Company.

Lighting will be provided to assure pedestrian and building security at night.

7.5.4 Plant Material

Plant materials will be deciduous trees in movable wood planters, species suggested include:

Trees

- Gleditsia triacanthos "Inermis" - Thornless Honeylocust
- Tilia cordata - Littleleaf Linden
- Platanus Acerfolia
- Acer rubra - Red Maple
- Malus species - Crabapples

Shrubs

- Juniperus secies - Juniper
- Euonymus alata - Winged euonymous
- Cornus servicea - Red stem dogwood

8.0 Storm Drainage

8.1 Boat Section Drainage

Storm drainage entering the ramps connecting with the CA/T project compiles with BWSC's position concerning the connection of highway drainage (under MDPW control) with the BWSC collection system.

In some instances providing separate outfalls for ramps drainage is not cost effective since the contribution from each of the ramps does not produce a significant discharge to warrant the high cost of separate outfalls. Therefore, the discharges from these ramps have been to the new surface drainage systems.

The peak 10-year return period discharge form the ramps to any single drainage system that will be owned by the BWSC will be less than 5 CFS

Currently, the project is proposing to discharge storm drainage from 3 MDPW owned pump stations into storm drains to be owned by the City. These pump stations are located near the Dock Square Parking Garage, the Mercantile Building and International Place.

8.2 Surface Street Drainage

The SDC should be aware of unusual features in the surface drainage design that must be included in the final design. Because of the close proximity of the tunnel roof to the grades of the surface artery in the area between Milk Street and Atlantic Avenue, the SDC must coordinate this surface drainage design with the structural design of the tunnel roof structure.

In these instances, the surface inlets and lateral drainage piping will be installed in conjunction with the construction of the tunnel roof concrete. The drainage lateral piping will be supported between the roof beams and exit through the slurry walls to a structure designed to catch grit and debris that might have entered the system before connecting with the separated storm drainage system.

The following drainage systems will require these special features.

System A: CANB Sta. 132+00 to Sta. 143+00
Between manholes at Stations 0+55 and 1+37. Penetration of the tunnel roof will be just outside the manhole at Station 1+37. In order to prevent leakage, the pipe material will be flanged ductile iron pipe and fittings.

System B: CANB Sta. 127+00 to Sta. 182+00 (Southbound side)
This whole system should be constructed with the tunnel roof. Surface inlets will be integral with and embedded in the tunnel concrete. Lateral drainage piping and fittings supported between roof beams will also be flanged ductile

iron. The main drain outside the slurry walls will require space in close proximity to the relocated steam line. Limited space is available between the outside face of the slurry wall and the building foundation, therefore, the SDC will be required to closely coordinate the location of the main drain with out the steam line.

System C: CANB Sta. 127+00 to Sta. 132+00 (Northbound side)
As described above for System B, System C should also be completely constructed with the tunnel roof since inlets and lateral piping will be similar.

System F: CANB Sta. 120+00 (Southbound side)
Most of the downstream portion of this system will be constructed under contract D014C. The upstream portions on High Street and Purchase Street should also be included in this construction.

System D & E: CANB Sta. 122+50 to Sta. 126+50
Outlets to these systems will connect to manholes that will be constructed under D014C. Provision will be made for stubouts at these manholes for the future connections of Systems D and E.

System G: CANB Sta. 113+50 to Sta. 126+50 (Northbound side)

System H: CANB Sta. 106+50 to Sta. 113+50 (Northbound side)

The remaining systems, G and H, can be constructed during the final phase of construction.

Inlets picking up runoff on the easterly side of the median infield area will also encroach on the tunnel concrete and should be constructed similarly as described above. However, the northbound surface street is adjacent to the east side slurry wall of the northbound roadway tunnel therefore no special conditions exist.

The remainder of the drainage system may be constructed during the final phase of construction.

9.0 Utility Relocaitons

9.1 Early Utility Relocation Corridors

Early utility relocation corridors were designed and constructed with the intention that the transverse utility crossings and longitudinal corridors within the limits of excavation bounded by the slurry walls will be protected and supported during C17A construction activities.

Undercarriage steel and pipe joint clamps for reinforced concrete pipe have been included with early relocated utilities installations within these corridors in anticipation of the proposed utility support system.

Two transverse utility crossing within this contract limit, (Oliver Street Transverse Crossing and Clinton, Commercial Street Transverse Crossing), are to be installed using jacked pipe. Oversized steel pipe casings were jacked across these corridors and the utilities inserted into these casings. These casings do not have undercarriage steel beneath them, so the SDC will have to design the supporting hardware for these casings.

The utility support system shall be designed to avoid any settlement, minimize any vibration being transferred to the utilities, and consider all resultant and expansive forces generated from pressurized systems.

Refer to Section 5.0 for the structural requirements of the utility support system.

Provisions also should be made to:

- Adequately protect all utilities during construction,
- Provide personnel protection for electrical and steam conduits and manholes,
- Provide freeze protection to all susceptible utilities,
- Maintain waterproofing to all electrical and communication conduits and appurtenances. Electric, communication and steam conduits have not been concrete encased within these corridors in order to minimize dead loads,
- Maintain access to all manholes and valving.

Upon completion of the mainline tunnel construction, and during the backfilling process, all utilities are to be properly reset upon properly compacted backfill material.

Due to the difficulty of properly compacting backfill under utilities, and the removal of undercarriage steel without disrupting the utility, a lean concrete cradle is to be considered between the utility and the properly compacted backfill.

This concrete cradle is to be poured around the undercarriage steel. When the concrete has cured, the tie rod supports can be removed.

Also, electrical, telephone, other communication conduits and steam line conduits are to be concrete encased in accordance to owners specifications, and allowed to cure before backfilling.

During the preliminary design phase, numerous meetings were held between the Management Consultant and the utility agencies/companies, including:

* Boston Water and Sewer Commission
* Boston Edison Company
* New England Telephone Company
* Boston Gas Company
* Boston Thermal Energy Corporation

Continued design coordination between the SDC and the above agencies/companies is required during the final design process.

Coordination and communication with other agencies during the final design process is also required. these include, but are not limited to, the following:

1. MBTA

   Coordination with the proposed Blue Line Station project at State Street. Coordination on the design of the AC and DC lines from Atlantic Avenue Avenue to State Street.

2. Boston Transportation Department

   Traffic detours during construction, construction vehicle routing and scheduling, parking impacts, traffic signal timing and phasing during construction.

3. City of Boston Public Works Department

   Pavement, sidewalk and planting area restoration requirements, street openings, site drainage, curb cuts, temporary pavements, pedestrian walkways.

4. MDPW

   Traffic relocation, pavement restoration, maintenance of pedestrian accessways

5. MWRA

   Regulatory control on outfall structures and other services.

9.2 New Utility Corridors

New Utilities are divided into the following corridors:

- Steamline, East India Row to "Walk to the Sea",
- 20" Gas Line, Oliver Street Transverse Crossing,
- Atlantic Avenue Utility Corridor,
- Temporary electrical conduit bridge crossing,
- Utility bridge, Dewey Square Tunnel portal.

Steamline, East India Row to "Walk to the Sea".

This contract will be responsible to design and construct a 24" steam and 8-inch condensate return lines and all associated appurtenance from the temporary terminus at East India Row to an existing 16" steamline located just north of the Marketplace Center Building, and just outside the proposed slurry wall. These lines are to be installed after the construction of the slurry wall.

20" Gas Line, Oliver Street Transverse Crossing.

This contract will be responsible to design and construct a 20" intermediate pressure gas line from a 30" intermediate pressure gas line in Purchase Street, near Oliver Street, to a future 20" intermediate gas line connection located at the intersection of Atlantic Ave. and the New Northern Ave. Bridge.

This line shall be a direct buried line installed during the mainline tunnel backfilling phase.

Atlantic Avenue Utility Corridor.

This contract will be responsible to design and construct the following utilities located in Atlantic Ave. from Congress Street to the Oliver Street Transverse Crossing terminus, including the two electrical conduit corridors from the Boston Edison substation and the extension of the AC and DC electrical conduits beyond the Congress Street limits to existing manholes in Atlantic Ave. midway between Congress and Summer Street

E (2-8.6") 115Kv
E 2-(9-5")
DC (14-4")
AC (10-4")
T (20-4")
LS 16"
HF 16"
HS 12"
G 6" LP
SM (24" & 8")
NESI 72"

The design within this corridor will have to take in consideration two other major projects, and a major electrical installation, Vent Building No. 3: the proposed MBTA "People Mover," and a Boston Edison Electrical Substation.

Vent Building No. 3 will be constructed along the Northeasterly side of Atlantic Ave., between the Russia Wharf Building and the Harbor Plaza Building, (470 Atlantic Ave.) This building will have a deep foundation with air supply and exhaust ducts passing transversely across Atlantic Ave. to the mainline tunnel.

The proposed MBTA "People Mover" will be routed along Atlantic Ave. from the northeasterly side of Vent Building No. 3 to Summer Street It will be placed atop the CANB mainline.

Boston Edison Co. has an existing major substation located to the rear of the proposed Vent Building No. 3 and a large conduit and manhole distribution system located in Atlantic Ave. This substation and distribution system has to remain operational and access for servicing and maintenance has to be maintained.

The combination of these elements within this corridor will require close coordination among all involved parties concerning construction sequencing, excavation, and temporary support systems.

Temporary Electrical Conduit Bridge Crossing

This contract will be responsible to design and construct a temporary electrical conduit bridge, from Atlantic Ave., over the existing Central Artery to Purchase Street, at approximate station 109+20, CANB.

This bridge will support four groups of E-(9-5").

These conduits must be adequately supported, water and weather proof and placed high enough to provide adequate clearance for the existing Central Artery traffic.

Bridge supports are to be placed so as not to interfere with any existing traffic. Transitional portions of conduit, (i.e., from Bridge Structure, through proposed slurry walls, to electric manhole), are to have personnel protection.

Upon completion of the mainline tunnels, these conduits and bridge structure will be replaced by underground conduits.

Utility Bridge, Dewey Square Tunnel Portal

This contract will be responsible to design and construct a utility bridge from Atlantic Ave. to Purchase Street, immediately adjacent to the existing Dewey Square tunnel portal.

This bridge shall be designed to support the following utilities:

2 Groups of E-(9-5")
E-(2-8.6") 115 Kv
LS 24"
HF 16"

HS 12"

The E(2-8.5") 115 Kv conduits extend from the portal on the Purchase Street side southerly to an existing 115 Kv manhole on Purchase Street between Summer Street and Congress Street.

Attention is called to the special requirements for 115Kv conduit. 115Kv conduits require welded steel conduits, large turning radiuses, separation from other utilities and strict personnel protection.

9.3 Minor Utilities and Service Connections

This Contract will be responsible to design, support, and protect all minor utilities and service connections slated to remain in service during and after construction.

Final Design Drawings shall incorporate all smaller utilities and service connections designated to be relocated, replaced or eliminated and a sequencing of events in order to minimize disruption of service.

Public and private agencies that may have utility services within the construction area, which will need protection from damage and, if necessary, temporary or permanent relocations, are:

- Massachusetts Department of Public Works
- Massachusetts Water Resources Authority
- Metropolitan District Commission
  City of Boston (Police, Fire, Transportation, and Lighting Departments)
- Boston Thermal Energy Corporation
- Western Union
- Sprint
- MCI
- McCourt
- Teleport
- Cablevision of Boston

Design effort shall also include all temporary facilities required to insure pedestrian safety and to maintain vehicular traffic flow.

Street lighting and other exterior lighting becomes an important safety issue during construction, and should remain in service as long as possible or be relocated. Traffic signalling, temporary or permanent, shall be coordinated with MDPW, Boston Transportation and other involved agencies in conjunction with Section 6.0.

10.0 Mechanical Systems

10.1 General

Final design of mechanical systems such as HVAC, fire protection, plumbing and drainage which are necessary to support Ventilation Building No. 3 and the planned air rights development above it shall be performed by the I-93 Central Artery North to Congress Section Design Consultant (D017A SDC) in accordance with the Directive and Standard Drawings, Project Design Criteria and Standard Special Provisions.

The D017A SDC will also be required to incorporate into the design, certain systemwide mechanical elements to be designed by the I-93 Mechanical/Electrical Systems Section Design Consultant (D020B SDC) which generally include embedded piping, fire standpipes, the structural formation of the tunnel ventilation air ducts, transitions, flues, ports, damper openings and fan spaces.

Directive Drawings have been prepared to identify how these systemwide mechanical elements integrate with the structural design of the tunnel sections and the ventilation building. Preliminary engineering has been performed to establish approximate equipment sizes, duct dimensions, flue and port quantities and spacing, pipe sizes, drainage requirements and to functionally coordinate and facilitate the arrangement and orientation of these elements with other systemwide elements and structural requirements.

The D020B SDC will be responsible for establishing the final design requirements for the tunnel ventilation, tunnel drainage and roadway fire protection systems including those elements requiring incorporation within the tunnel sections and ventilation building structural design. The D020B SDC will also provide Directive Drawing verification, technical guidance and general coordination of these elements which affect the design work of the D020B SDC.

10.2 Tunnel Ventilation

Ventilation within the I-93 Central Artery tunnels and their associated ramps will be provided as part of a multi-zone full transverse ventilation system. Ventilation Building No. 3 will house the fourteen exhaust and nine supply fans which are required to provide the necessary amounts of supply and exhaust air to these tunnel sections and associated ramps.

With this type of ventilation system, fresh air is supplied via continuous ducts located beneath each mainline tunnel roadway. These ducts will be formed as part of the tunnel structure. The fresh air is delivered at curb level, along both sides of the roadway, through a series of embedded flues placed at predetermined intervals for the entire length of the tunnel.

Exhaust air is collected through ports in the ceiling and transported back to the ventilation buildings via a continuous duct which is formed above each mainline roadway between the underside of the tunnel roof slab and the finished ceiling. The location and positioning of a number of the associated ramps will require side ducting of the supply and exhaust ducts.

Preliminary engineering has been performed to estimate the minimum duct cross-sectional area required for exhaust and supply air so as not to exceed the maximum allowable air velocities in the ducts. Since lower velocities are preferable, the design of the exhaust air ducts shall make maximum utilization of the available space above and below the roadways by providing as large a cross-sectional duct area as is physically possible within the structure. Due to varying widths of the tunnel roadways and the need to dispense supply air from each walkway, two supply air ducts are provided under each mainline roadway in order to efficiently connect flues to each curb.

The mechanical Directive Drawings reflect the preliminary engineering of those elements of the ventilation system which affect final design of the I-93 Central Artery North to Congress tunnel structure and Ventilation Building No. 3; these include supply air duct cross-sectional area, supply air flue geometry and spacing, tunnel-to-building transitions, and fan equipment arrangements and spacing. Verification of this information will be performed by the D020B SDC who is responsible for the final design of the ventilation system.

10.3 Tunnel Drainage

A drainage system will be included within the I-93 Central Artery North to Congress tunnel and associated ramps. This drainage system is distinct from the storm drainage system and from the stormwater pump stations which are designed to collect run-off in the tunnel approaches adjacent to the portals and to prevent stormwater from entering the tunnel at the portals.

For the purposes of design, it has been assumed that during a 50-year storm event, a certain amount of run-off will be-pass the transverse storm drain at the portal(s) and thus contribute influent to the tunnel drainage system. Another major contributor considered in the preliminary design of the tunnel drainage system is the amount of water resulting from fighting an in-tunnel fire.

Although there are other contributors to the tunnel drainage system such as vehicle drippings, structure seepage and ventilation duct drainage, these are all assumed to be negligible and considered to have no effect on the system's capacity. Preliminary calculations of inflow resulting from tunnel wash down operations indicate that this flow would be less than that of a fire fighting operation.

The tunnel drainage system, as described in the "Tunnel Drainage Concept Report," consists of an embedded gravity drain pipe running longitudinally below the curb on the low side of each super-elevated roadway which will collect the drainage water through inlets spaced at a maximum of 75 feet. In the Central Artery area, the drainage flows to low points of the tunnels. From the low points the drainage is directed to a low point pump station located in Ventilation Building No. 3. After primary treatment by oil/water separation the effluent is discharged to an adjacent combined sewer.

The drainage low points (station, elevation) of the Central Artery North to Congress Tunnel and its associated ramps as described in the "Tunnel Drainage Concept Report" are as follows: low point CANB (Sta. 100+75, EL. 30.5), low point R-T (Sta. 114+00, EL. 71.5), low point CASB (Sta. 119+45, EL. 44.0), low point CS-P (Sta. 125+00, EL 73.2), low point A-CN/RT (Sta. 122+06, EL. 69.6). All of the low points listed above except for low point CANB connect to a conveyance situated between CASB and ramp R-T which directs their collective flow by gravity to Pump Station D-1 located in Ventilation Building No. 3. Low point CANB is connected directly (gravity flow) to Pump Station D-1. Pump Station D-1 provides pumping capacity for pumping the collected drainage to the 72-inch diameter New East Side Interceptor (NESI).

The D020B SDC will be responsible for overall final design of the tunnel drainage systems including all pumps, valves, exposed intermediate piping, motor starters, oil/water separators and other appurtenances. The D020B SDC will also provide verification of the preliminary engineering and directive information including piping dimensions, piping requirements and inlet spacing and sizes affecting final design of the I-93 Central Artery North to Congress area structures.

The elements of the tunnel drainage system which are to be designed as part of the I-93 Central Artery North to Congress tunnel and associated ramps structure include embedded gravity drain pipes and inlets, embedded and buried discharge piping and all miscellaneous embedded drains such as the walkway gutter drains, exhaust air duct drains and miscellaneous niche drains which will discharge directly on the roadway.

10.4 Fire Protection

As described in the "Fire Protection Concept Report," numerous subsystem elements will be integrated to provide an efficient and effective fire protection and detection system throughout the Central Artery/Third Harbor Tunnel project. As a part of this overall fire protection system, a system of dry standpipe zones shall be provided within the tunnels.

Within the tunnel and associated ramps, the system shall consist

of a single main header mounted above each ceiling. A riser will extend from the main header down to a niche, providing a two-way gated hose valve connection mounted against the wall. Each zone shall be capable of being pressurized from either end via at-grade siamese hydrants. The specific location of these hydrants shall be coordinated with and approved by the City of Boston Fire Department.

Verification of pipe sizes, valve arrangements and system schematic will be performed by the D020B SDC. The D017A SDC is responsible for the preparation of contract plans for the fire protection system.

10.5 Temporary Mechanical Systems

Temporary systems will be necessary during construction of the I-93 Central Artery North to Congress tunnel and associated ramps. These systems include de-watering, heat and ventilation for the health and safety of workers, and a water supply and standpipe system for fire protection. The permanent mechanical systems for tunnel drainage, ventilation and fire protection are not to be considered available for use by the construction contractor(s) during construction.

The above requirements shall be reflected by the D017A SDC in the contract documents for the construction of the I-93 Central Artery North to Congress tunnel and associated ramps and shall include all codes, regulations and/or guidelines pertinent to the provisions of such temporary systems.

11.0 Electrical Systems

11.1 General

Final design of the electrical systems necessary for Ventilation Building No. 3, Storm Water Pump Stations 17A-SW01, 17A-SW02, and 17A-SW03 and surface street lighting, shall be performed by the D017A Section Design Consultant, in accordance with Project Design Criteria and Standard Special Provisions, Directive Drawings and Standard Drawings.

The D017A SDC shall incorporate into the design certain electrical elements which will be designed by the I-93 Mechanical/Electrical Section Design Consultant (Contract D020B). Contract D020B electrical elements include, but are not limited to, the following: specific embedded conduits and pull boxes, manholes, grounding system, ramp exterior roadway lighting pole foundation locations and space requirements for major electrical equipment such as switchgear, unit substations, motor control centers, generators and electrical panels. Additional specific electrical elements with which the D017A SDC shall coordinate are discussed in Chapter 12, Integrated Project Control Systems (IPCS).

Directive Drawings have been prepared to assure compatibility of the tunnel design with the projectwide electrical system. Preliminary engineering has established approximate equipment sizes, conduit and pull box sizes, quantities and locations, manhole sizes and locations and ramp exterior roadway light pole locations and facilitated the typical arrangement and orientation of these elements with other projectwide elements and structural requirements.

The D020B I-93 Mechanical/Electrical Section Design Consultant and the IPCS Section Design Consultant (Contract D022A) have final design responsibility for the mechanical, electrical and IPCS systems. They will be responsible for verifying the electrical information shown on the Directive Drawings. The Contract D020B and Contract D022A Section Design Consultants will provide technical guidance and general coordination to the D017A SDC. The Construction Documents for the embedded items shall be the responsibility of the D017A Section Design Consultant.

The following sections provide a description of each of the electrical systems and how they affect the final design of I-93/Central Artery Causeway Street to North Street. IPCS related electrical systems are described in Chapter 12.

11.2 Tunnel and Exterior Roadway Lighting

11.2.1 Tunnel Lighting

The tunnel lighting system will consist of multiple rows of fluorescent lighting fixtures mounted on the ceiling. Tunnel

portal (entrance) lighting will be supplemented by low pressure sodium (LPS) lighting fixtures. Typical locations and mounting details are shown on the Directive Drawings.

The lighting fixtures will be fed from two independent distribution circuits. Tunnel lighting circuits will be arranged so that alternate rows are fed from an alternate source to minimize the impact due to the loss of a circuit. Additional lighting circuits, originating from an uninterrupted power supply will provide standby power to certain lighting fixtures. Typical conduit and pull box requirements for the lighting circuits are shown on the Directive Drawings.

11.2.2 Exterior Roadway Lighting

Lighting of exterior ramps will be from pole mounted high pressure sodium (HPS) luminaires as shown on the Directive and Standard Drawings.

Pole foundations shall be designed per the Project Design Criteria, Section VIII - Electrical. Typical locations, mounting details and conduit and pull box requirements are shown on the Directive and Standard Drawings.

Lighting of surface streets shall be designed by the D015A Section Design Consultant in accordance with the standards of the Authority Having Jurisdiction over the roadway, i.e. City of Boston Public Works Department.

Electric service for lighting of exterior ramps will be supplied from load centers located in Ventilation Building No. 3. Electric service for lighting of surface streets shall be supplied by extension of existing street light wiring.

11.3 Power Distribution

11.3.1 General

The power distribution system will distribute primary power from the Boston Edison Company (BECO) to project ventilation buildings. From the ventilation buildings, secondary power will be distributed to tunnel ventilation, roadway drainage, lighting, IPCS, building service, and various miscellaneous electrical loads. One-line diagrams of the power distribution system are shown on the Directive Drawings.

11.3.2 Primary Distribution

The primary switchgear equipment will be located in the ventilation buildings and will be interconnected by two feeders, creating a power distribution network at a voltage level of 13,800 volts. The power source for this network will be three BECO substations, each providing two independent feeders.

Two 13.8 kV ductbank and pull box systems, one in each roadway

(north bound and south bound), will provide redundant routes for the interconnection of primary power between Ventilation Building Nos. 4, 3 and 1.

11.3.3 Secondary Distribution

Secondary voltage will be required at 480/277V, and 208/120V levels. The 480/277V will serve the ventilation fan motors, roadway lighting, IPCS, drainage pump motors, and building service loads. Power at 208/120V will be derived by local, dry-type transformers from the 480V system, and will serve building service and IPCS loads.

The D017A Section Design Consultant shall design the building service electrical distribution system in accordance with the Project Design Criteria and Standard Special Provisions.

The D020B I-93 Mechanical/Electrical Section Design Consultant will be responsible for identifying the conduit system and structural opening requirements for the major electrical equipment for which he has final design responsibility. The IPCS Section Design Consultant will be responsible for identifying similar requirements for the IPCS equipment. The D017A SDC shall be responsible for the Construction Documents of the embedded portions of these conduit systems and any structural openings required for the major electrical and IPCS equipment.

Typical requirements for conduit systems embedded in the roadway structures are shown on the Directive Drawings.

11.3.4 Stand-By Power

A diesel engine generator located in Ventilation Building No. 3 will provide standby power in the event of a loss of normal power. Standby power loads are identified on the Directive Drawing showing the Ventilation Building No. 3 one-line diagram.

The provision for a fuel oil storage tank shall be designed by the D017A SDC in accordance with all State and Federal regulations.

Two separate uninterrupted power supplies (UPS) located in Ventilation Building No. 3 will provide uninterrupted power to selected loads. One UPS will be provided for IPCS loads. The other UPS will be provided for tunnel lighting, ventilation building standby lighting and circuit breaker control loads.

11.4 Temporary Construction Electrical Systems

During construction, a temporary lighting system, including emergency lighting, will have to be provided. Past projects have successfully used high pressure sodium lighting during construction. The design of this system shall be the responsibility of the D017A SDC. The design should include identifying necessary equipment, location of equipment and maintenance of the system.

During construction, an interim power system will be provided by the contractor. The design of this system shall be the responsibility of the D017A SDC identifying service voltage levels, necessary equipment, location of equipment and maintenance of the system.

Requirements for turning the interim lighting and power systems over to follow-on contractors must be identified.

The D017A SDC shall include all codes, regulations and/or guidelines pertinent to the provisions of the above temporary systems in the Construction Documents.

11.5 Corrosion Control

Corrosion control for all steel structures, steel reinforcing, fire protection system and fuel oil storage tank, if steel, shall be designed in accordance with the Project Design Criteria, Standard Special Provisions, Directive Drawings and Standard Drawings.

11.6 Ventilation Building No. 3 Auxiliary System

Besides the building services conduit systems described above, the D017A Section Design Consultant shall design the following electrical systems, in accordance with Project Design Criteria and Standard Special Provisions:

- Building service power system
- Lighting, interior and exterior
- Fire detection and alarm system
- Security system
- Lighting protection

The IPCS SDC (D022A) will develop the IPCS final design. The D017A SDC will exchange design and equipment installation information with the D022A SDC. The information exchange will typically involve installation data for IPCS equipment located in Vent Building No. 3. The D017A SDC will design the facility to meet the IPCS requirements. The final installation shall be done by C022A.

12.0 Integrated Project Control System (IPCS)

12.1 General

The design of the Integrated Project Control System is the responsibility of the D022A Section Design Consultant. The system is described here to provide the D017A Section Design consultant (SDC) with a better understanding of the completed project.

The overall system, as planned, will be integrated, with thousands of signals that will be transported over fiber optic links between the centralized information display/decision/ control points and a distributed network of many intelligent multipurpose Remote Terminals Units (RTUs). Visual support in the form of Closed Circuit Television (CCTV) as well as associated telephone and radio voice communications systems are also planned. The Integrated Project Control System will support all administrative maintenance, tactical and emergency responses.

A key item for D022A is the location of the Remote Terminal Units (RTUs). In general they will be located near concentrations of input/output points. This includes cross-passage/utility rooms, and vent building No. 3.

Another key element of D022A is selection of the cross-passage/utility rooms for IPCS purposes. Selection for a particular room is dependent upon the distance from the sensor/display to its controller. The limiting factor is the TSCS, more specifically the Variable Message Sign (VMS). This sign must be located within 300 cable feet of its controller.

All IPCS cabling including fiber optic, where ever possible will be routed via embedded conduits.

12.2 Centralized Operations

Both operator and supervisor level staff will exercise control from either of two redundant Operations Control Centers (OCCs) using consoles dedicated to single or groups of functions Data will be collected during normal operation on the basis of polling for exceptions, with control being chiefly semiautomatic with manual override capability.

Voice communications between personnel at the OCCs, Toll Plaza, Maintenance Center, along the roadways of the project and off site, whether at fixed or mobile locations, is to be accomplished using radio and telephone.

12.3 Individual Systems

- Traffic Surveillance and Control System (TSCS)

The TSCS will provide automatic monitoring of traffic movement with incident being alarmed at the control center. The TSCS will also provide control of traffic movement through variable message signs and signals. Operationally, the system will be configured based on supervisory control strategies, which are initiated either manually by the operator or as an automatic response to an incident situation.

Remote Terminal Units (RTUs), for localized concentration of sensor data and dissemination of control signals, will be located in utility rooms. Signs and CCTV cameras will generally be located over the vehicle travel lanes. In certain sections and ramps, they may be on the walls. Loop detectors will be located in the roadway pavement. Overheight attenuators will be located at appropriate portals and entrance ramps.

o Ventilation and CO Level Control

The ventilation system will be controlled on a zone basis. CO will be monitored and air flow level adjusted through the use of local fan controllers which are interfaced to RTUs.

o Electrical Load Distribution Control

The system will monitor status of electrical power distribution for specific loads and provide limited control to allow load shedding and circuit breaker operation.

o Fire Detection

Basic fire detection will be accomplished via a linear heat detecting tube in each bore, suspended from the ceiling. Additional "spot" detectors will be provided. The fire detection and protection system will be capable of independent use by the Boston Fire Department (BFD). Sensors will be wired directly to both the BFD and the IPCS. A zone concept will be employed, utilizing automated detection, manual pull stations, and emergency telephones. The IPCS will monitor the status of the suppression equipment but will not control it.

o Security

The security system includes intrusion detection in cross passages and utility rooms, escape stairways and vent building No. 3. The security system will provide access control to designated areas such as vent building no. 3.

o Drainage Control

The drainage systems will operate under a similar control regimen as that proposed for ventilation. Additional considerations for fuel/oil collection and disposal will be taken into account. Hydrocarbon detection devices will be provided at the sumps and will be monitored, with associated alarm signals sent back to the OCCs.

o Communications Facilities

Two basic communications systems will be available to CA/T personnel providing voice contact with others:

1. Telephone instruments will be located throughout the CA/T project. They will be connected to branch exchanges which will allow supervisory programmed access to other telephone instruments in both the public and private sector. A telephone will also be located in each "cross-passage" to provide voice communications throughout this area.

2. Two-way radio systems will be available to contact agencies providing service on the CA/T roadway network. Highway Advisory Radio is planned to broadcast messages to the motoring public. The basic radio communications medium will be redundant broad spectrum radiating cable.

13.0 Operations and Maintenance

13.1 General

The operations and maintenance concepts are presented here to provide the Section Design Consultant with an overall understanding of the completed project. Detailed requirements will be described in the Operations and Maintenance Manual. Factors for the SDC to incorporate into their project design should include:

- o System Component labelling.
- o Product consistency, i.e., minimize the number of vendors for each equipment type.
- o Transferral of all vendor catalogs and data sheets to project operator.
- o Evaluation of spare parts and specialized tool requirements.
- o Product reliability statistics.

13.2 Operating Concepts

The following subsections provide a brief description of the operating parameters and the control philosophies.

13.2.1 Traffic

The TSCS portion of the IPCS monitors motorist activity and provides for minimum delays and optimum throughout by providing the operations staff with accurate and current information. Operators will evaluate the information, choose from the menu options and implement the various traffic strategies necessary to alleviate congestion.

The D022A SDC will develop response procedures to include the following actions by the operations staff pertaining to traffic surveillance and control.

- o response to a detection alarm
- o verification by CCTV monitors, roadway display graphics or on-site personnel
- o dispatching emergency response crews
- o implementing pre-selected traffic control strategies
- o broadcasting of radio messages to motorists
- o supervising operations via CCTV
- o advising outside agencies affected by changes in conditions

A number of strategies will be developed to handle the changing roadway conditions.

Traffic control strategies will include:

- o Normal Traffic Flow
- o Lane and Roadway Closure
- o Congested Traffic Flow

- Incidents
- Fire
- Roadway surface changes
- Visibility changes

13.2.2 System Monitoring

The IPCS will report on the status of all project equipment. In addition to the traffic related equipment, the OCC will be provided with both warning and trouble alarms on various mechanical and electrical equipment. A few of the conditions to be monitored are as follows:

- traffic volume and occupancy detectors
- mechanical and electrical equipment status
- carbon monoxide and hydrocarbon levels within confined areas
- security alarms
- overheight and overweight vehicle detection

When the equipment produces an alarm, the operator will choose from a menu of options which will rectify or address the immediate condition and will notify maintenance supervision. There will be close coordination between both the operations and the maintenance staff until the equipment is back in operation.

13.2.3 System Control

Given the magnitude of this project and the number of systems and equipment, there is a need for remote as well as local control.

Control strategies will be developed for the following:

- bypass configuration during repair and replacement
- emergency operations
- abnormal condition response
- fire detection and suppression system monitoring.

The strategies will require both internal and external agency coordination

13.2.4 Fire Protection/Detection

There are several devices which will signal a fire. Operators will verify the severity and type of fire using in-tunnel CCTV and will view their monitors for alarm condition locations. The OCC will also initiate a call to the Boston City Fire Department dispatcher via direct telephone line to verify the alarm and location plus set up a communications link with responding units.

Ventilation fans for the zone in which the fire is located will be switched to the exhaust mode and the supply side will be reduced. Ventilation strategies are complex and will be modeled for the facility.

13.2.5 Policing

The State Police will be governed by the present agreement between the Department of Public Safety and the Massachusetts Turnpike Authority.

The project will also be employing ramp metering during peak periods which will require enforcement. All communications between the State Police and the facility will be directed through the Operations Control Center. The State Police frequency will be monitored by the Control Center for reports concerning the operations and maintenance of the Central Artery/Tunnel Facilities.

13.2.6 Emergency Access/Egress

In the event of an emergency, the Operations Control Center may need to evacuate a portion of the facility. Emergency stairs are being designed both for the egress of motorists and the access of emergency and fire personnel.

Cross passages between tunnel sections will also be monitored by the OCC. All doors will be numbered for quick identification on a graphic alarm system.

13.2.7 Security

The OCC will also oversee the security of the entire facility. Operators will be notified of an intrusion into any of the project buildings and will contact the appropriate enforcement agency for response.

13.3 Maintenance Concepts

Maintenance activities can be divided into one of five categories:

1. Inspecting
2. Testing
3. Cleaning
4. Preventive Maintenance
5. Repair and Replacement

13.3.1 Inspections

Inspection schedules will be generated based on manufacturers recommendations and shall be conducted to identify early warning signs of failure.

13.3.2 Testing

Testing of all equipment shall be scheduled to check performance and control logic. Testing shall be accomplished periodically to assure equipment meets specifications.

Uninterrupted power supplies and battery systems will be checked periodically. Fan cycling and speed control will also be checked periodically. Corrosion control systems will require frequent scheduled testing.

13.3.3 Cleaning

An aggressive cleaning program is required. Maintenance personnel will be performing basic janitorial duties within each of the facilities buildings including cleaning floors, washing windows, refuse removal and servicing rest rooms. There will be a need to pressure wash the buildings regularly, and clean up including sweeping of roadways. The clean up of the grounds and park lands are also required. Cleaning will also be required on the drainage systems and throughout the project's major structures.

With an average annual snowfall of 42 inches in the Boston area, snow removal activities will be carefully planned and implemented by the operations and maintenance group. Ramps and boat sections will be cleaned to provide minimum disruption to traffic flow.

13.3.4 Preventive Maintenance

All project equipment will be incorporated into a component and system labelling program. Under this format, a computerized maintenance management system will be instituted in which a scheduled preventive maintenance program will be implemented.

13.3.5 Repair and Replacement

There will be a need for both repair and replacement of equipment. It will be necessary to maintain spare parts and provide storage, a computerized system for inventory control, and warranty administration.

Equipment will be transported to the central maintenance site for replacement or will be brought to an electrical/ mechanical workshop to be repaired.

Each of these four maintenance categories will need to be provided on the project. These elements can be grouped under the following headings.

- Major structures
- Roadways and grounds
- Vehicles and heavy road equipment
- Mechanical and electrical equipment

13.3.6 Major Structures

Major structures on the CA/T Project include:

- Third Harbor Tunnel
- Seaport Access Tunnel
- Central Artery Underground Freeway
- CANA Ramps
- South Boston Interchange
- Service and Administration Building
- Toll Plaza Facility
- Ventilation Buildings
- Emergency Stations
- Roadway Maintenance Buildings
- Pump Stations
- Electrical Substations
- I-93/I-90 Interchange
- East Boston Interchange

13.3.7 Roadway and Grounds

There will be a need to maintain residual land adjacent to the roadway. This will include the maintenance of all trees, shrubs, flowers and grass.

13.3.8 Vehicles and Heavy Road Equipment

The maintenance group will be responsible for the upkeep of all the facility vehicles and equipment. They will install the necessary equipment into all State Police Vehicles and provide any necessary repairs.

13.3.9 Mechanical and Electrical Equipment

A preliminary list of M&E equipments to be maintained is as follows:

- 13.8 KV Substations
- 13.8 KV 480 V Unit Subs
- Motor Control Centers
- 13.8 KV Breakers
- Diesel Generators
- Battery Rooms
- Ventilation Fans
- Drainage Pumps
- Numerous roadway and tunnel lights.

14.0 Right-of-Way Impacts

14.1 Major Property Owners

The major property owner in this Contract is the City of Boston. The properties are used mainly for off street parking. Other property owners include, but not necessarily limited to, are the Boston Redevelopment Authority, the Boston Edison Company and the Commonwealth of Massachusetts Department of Public Works.

14.2 Impact Upon Properties

The impact upon properties will vary. There will be a fee taking, permanent highway easement takings and some temporary construction easements. The majority of permanent property impact should be within the existing State Highway location lines as established in the 1950's.

14.3 Affected Buildings

There should be no right-of-way impacts to any buildings in this Contract.

15.0 Traffic Engineering

15.1 General

This chapter of the Preliminary Design Report describes the forecasted traffic operating conditions on the highway and local street system within the Design Contract D017A portion of the Central Artery (I-93)/Tunnel (I-90) Project (CA/T Project). All of the CA/T Project Design Contract D017A project components are located within the City of Boston. The existing I-93 Northbound and Southbound mainline roadway through the City of Boston is commonly referred to as the Central Artery within the Congress Street to North Street corridor. The Central Artery area of the CA/T Project contains the following major highway components as shown in Figure 15.1, Proposed Action, Design Contract D017A Project Alignment.

- A new I-93 Northbound mainline roadway tunnel beginning under Atlantic Avenue (south of Kneeland Street) ending north of Causeway Street where the I-93 Northbound mainline roadway emerges from tunnel to cross over the Charles River on viaduct.

- A new I-93 Southbound mainline roadway tunnel starting just north of Causeway Street, where the roadway has descended from the Charles River viaduct to Congress Street. Continuing south from Congress Street, the I-93 Southbound mainline roadway enters the existing Dewey Square Tunnel to the terminus just south of Kneeland Street The Dewey Square Tunnel will be reconstructed in order accommodate the proposed I-93 Southbound mainline roadway alignment.

- A new below grade interchange connecting the existing Sumner and Callahan Tunnels directly to the Central Artery roadway system to and from the north.

- A continuous northbound and southbound surface arterial street system from Kneeland Street to Causeway Street, composed of new and existing roadways. Under the Proposed Action alignment the existing arterial street system will be rebuilt and extended from approximately North Street to Causeway Street.

- New on and off ramps from the Proposed I-93 Northbound and Southbound mainline Tunnel roadway system to the surface arterial street system.

- New extensions to the local roadway system between the proposed northbound and southbound surface arterial streets within the existing Central Artery corridor.

The CA/T Project Design Contract D017A I-93 Northbound mainline study area limits from south to north extend from Congress Street to North Street. The I-93 Southbound mainline Design

FIGURE **15.1**

PROPOSED ACTION-DESIGN CONTRACT D017A PROJECT ALIGNMENT

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT

0 400 800 1600 Feet

Contract D017A limits extend from High Street to North Street. To the east and west, the Design Contract D017A study area is bounded by the proposed northbound and southbound surface arterial street system included under the CA/T Project Proposed Action alignment. CA/T Project components included in the Design Contract D017A study area include the I-93 Northbound and Southbound mainline highway elements and the local street system roadway network improvements considered relevant to the operations of the CA/T Project highway components.

This report addresses future travel demand and general traffic composition and then proceeds to a detailed discussion of operations of the I-93 mainline, ramp, and surface streets within the CA/T Project Design Contract D017A study area.

The traffic operations of the CA/T Project area components located just to the north of the Design Contract D017A limits (North Street to Causeway Street) are addressed within the Design Contract D015A contract documents. North of Design Contract D015A, the traffic operations of the CA/T Project components are discussed in reference to Design Contract D019A and D019B within the I-93/Central Artery Causeway Street To North Area Limits Traffic Report. To the south of the Design Contract D017A limits, traffic operations of the CA/T Project area components are discussed in reference to Design Contract D011A and D018A within the I-93/Central Artery Kneeland Street Causeway Street Traffic Report and within the specific design contract documentation. Year 2010 - Design Year Traffic Volume Estimation

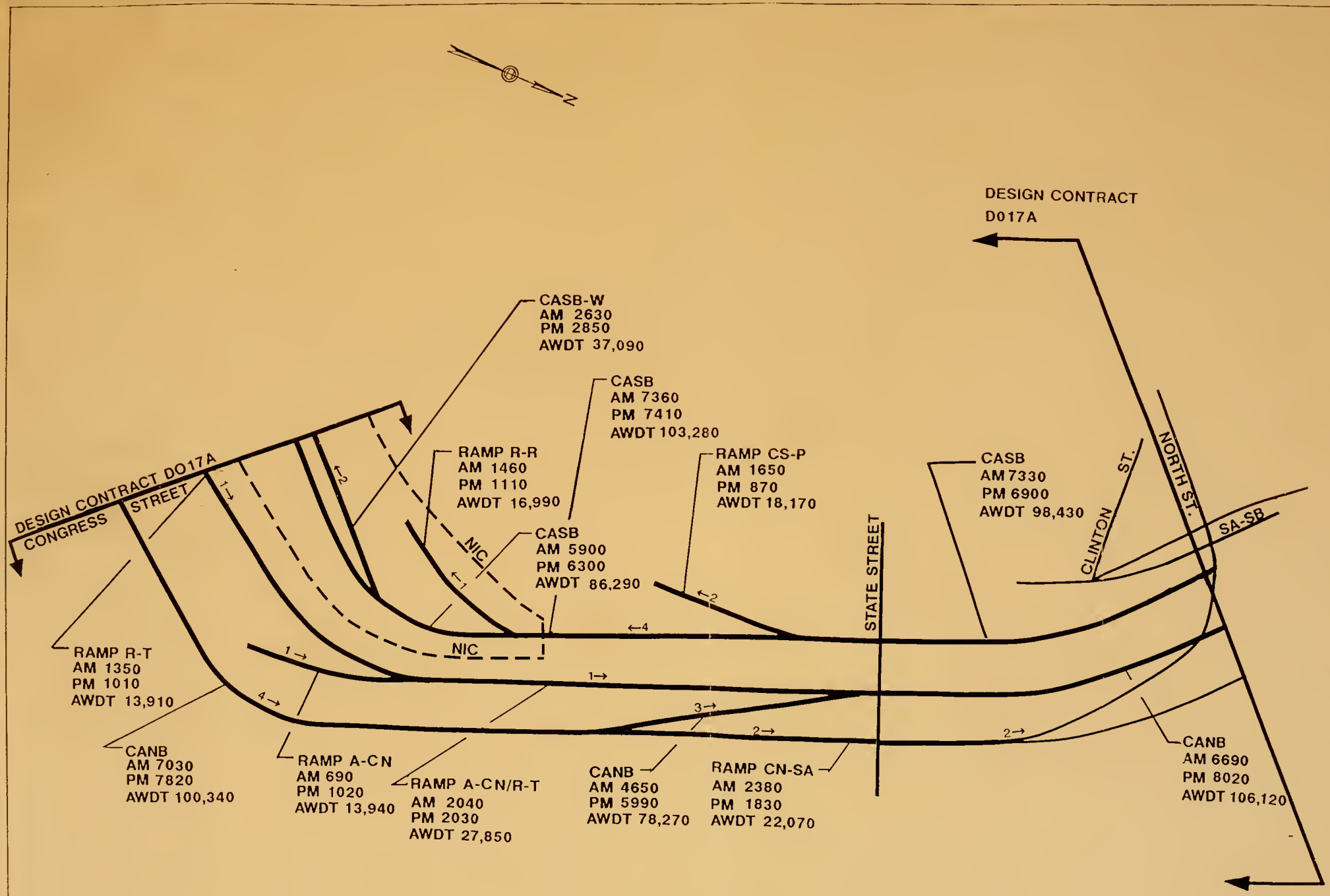
Year 2010 and 1998 traffic volume forecasts were generated using the CA/T Project TRANPLAN travel forecasting computer model. The Year 2010 is the CA/T Project design year and 1998 is the scheduled construction completion date for all project components within the Central Area. The TRANPLAN travel forecasting model predicts total travel demand throughout the CA/T Project study area based on land use activity forecasts and an estimate of vehicle trips generated per unit of land use activity and accessibility. The trips generated are then assigned to the study area roadway network based upon the criterion that a vehicle will travel from its origin to its destination along the route requiring the least travel time. A more detailed description of the travel forecasting methodology is documented in the Central Artery/Third Harbor Tunnel Project Detailed Travel Model Documentation Report.

From the CA/T Project TRANPLAN travel forecasting computer model, AM and PM peak hour traffic volumes within the project study area boundaries were generated for analysis purposes. The Average Weekday Traffic (AWDT) volumes within the CA/T Project study area boundaries were generated for comparison purposes. The AM and PM peak hour traffic analyses of the CA/T Project roadway components located within the Design Contract D017A limits are discussed later in this report.

Figure 15.2, Proposed Action, Design Contract D017A Project Alignment Major Facilities Traffic Volume Forecasts, Year 2010, shows the projected AM and PM peak hour traffic and AWDT volumes forecasted for the I-93 mainline roadways located within the Design Contract D017A limits. Figure 2 also displays forecasted traffic volumes for all of the I-93 mainline roadway ramps which interconnect with the surface arterial street system.

Figure 15.3, Proposed Action, Design Contract D017A, Selected Roadway Forecasted Peak Hour and AWDT Volumes, Year 2010 shows the AM and PM peak hour traffic volumes and AWDT traffic volumes on selected surface street system roadways within the CA/T Project Design Contract D017A limits. The surface arterial and local street Design Year 2010 TRANPLAN generated AM and PM peak hour turning movement traffic volumes within the Design Contract D017A limits are shown on Figure 15.4, Proposed Action, Design Contract D017A, Peak Hour Intersection Turning Movement Volumes, Year 2010. The local street peak hour traffic operations forecasted for the Year 2010 are discussed within the I-93/Central Artery Central Area Traffic Report.

The year 1998 peak hour traffic volumes forecasted for the local street system within the Design Contract D017A limits are shown on Figure 15.5, Proposed Action, Design Contract D017A, Selected Roadway Forecasted Peak Hour Volumes, Year 1998 and Figure 15.6, Proposed Action, Design Contract D017A, Peak Hour Intersection Turning Movement Volumes, Year 1998.

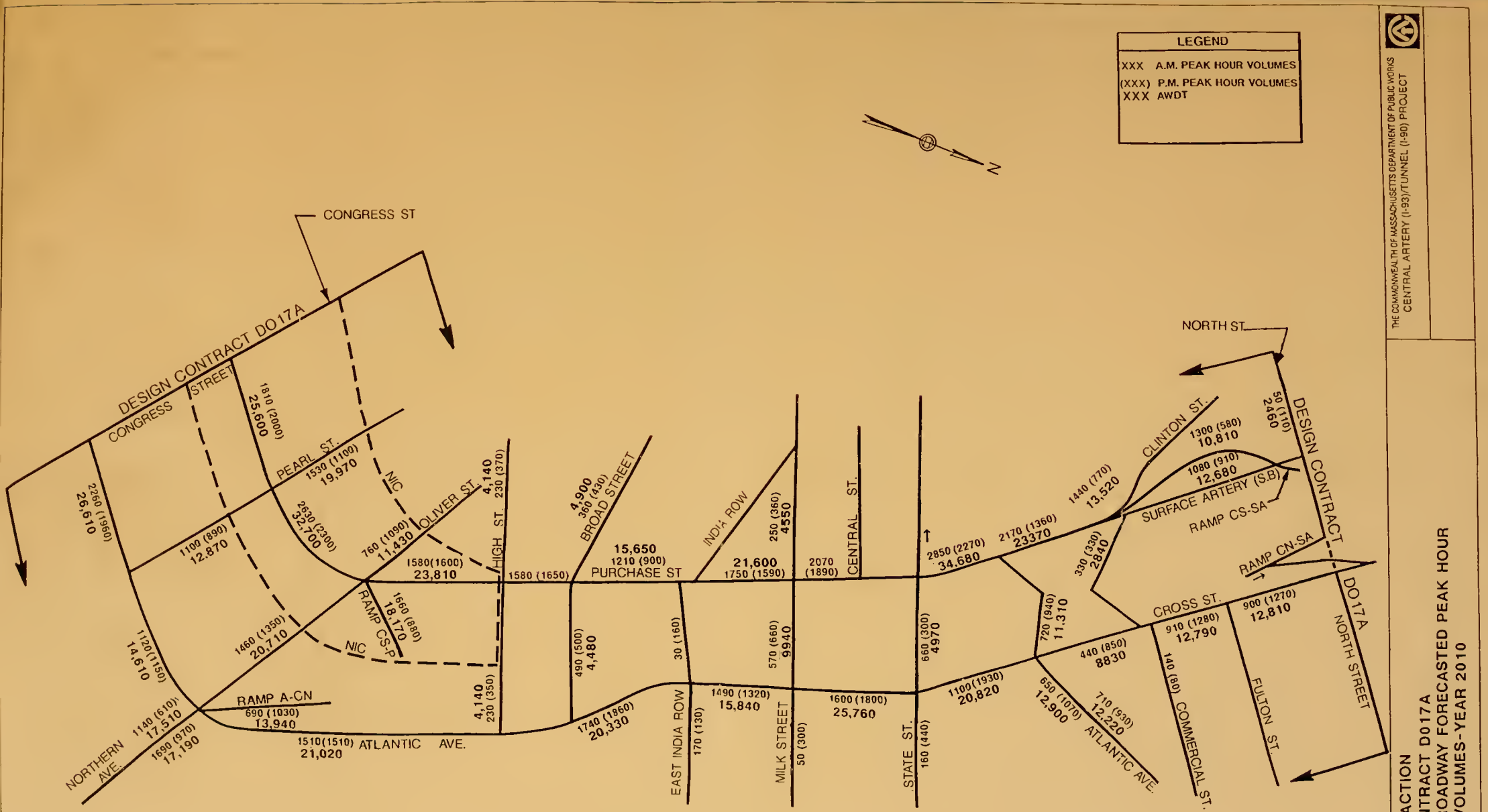


DESIGN YEAR 2010

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT

PROPOSED ACTION
DESIGN CONTRACT D017A PROJECT ALIGNMENT
MAJOR FACILITIES TRAFFIC VOLUME FORECAST
YEAR 2010

FIGURE 15.2

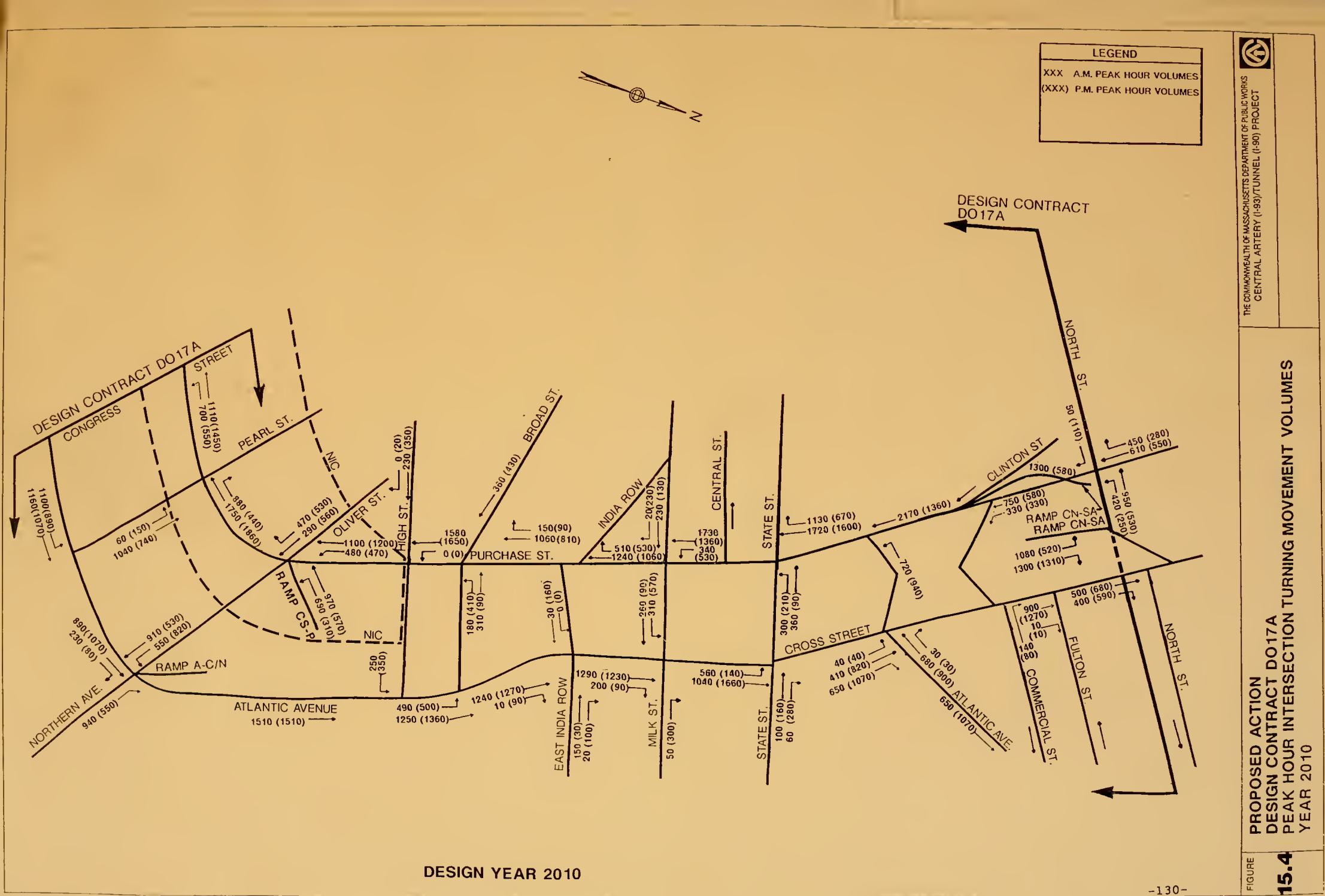


DESIGN YEAR 2010

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT

FIGURE 15.3

PROPOSED ACTION
DESIGN CONTRACT D017A
SELECTED ROADWAY FORECASTED PEAK HOUR
AND AWDT VOLUMES-YEAR 2010

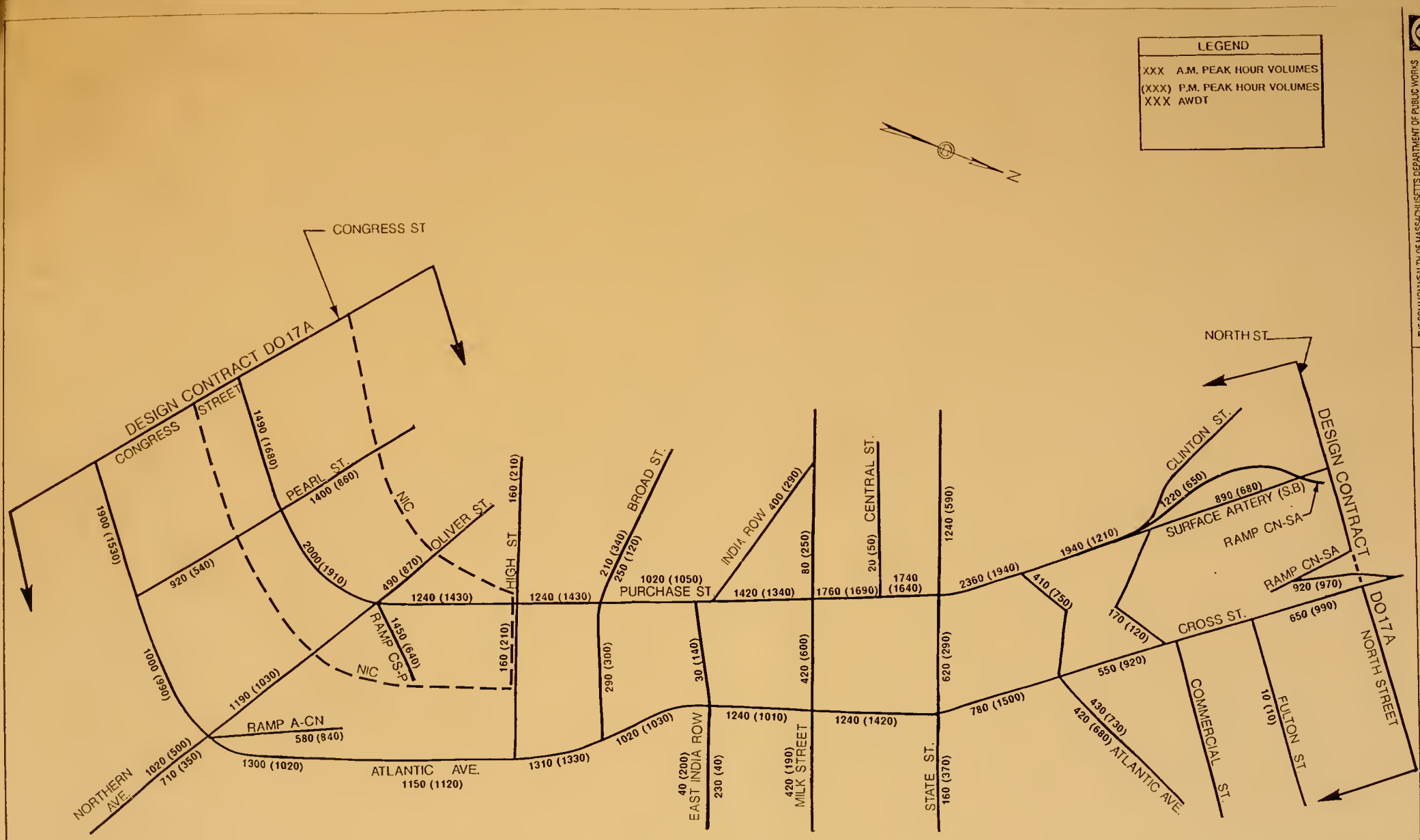


DESIGN YEAR 2010

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT

FIGURE 15.4

PROPOSED ACTION
DESIGN CONTRACT DO17A
PEAK HOUR INTERSECTION TURNING MOVEMENT VOLUMES
YEAR 2010



YEAR 1998

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT

FIGURE 15.5

PROPOSED ACTION
DESIGN CONTRACT D017A
SELECTED ROADWAY FORECASTED PEAK HOUR VOLUMES
YEAR 1998

YEAR 1998

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY (I-93)/TUNNEL (I-90) PROJECT

FIGURE 15.6

PROPOSED ACTION
DESIGN CONTRACT DO17A
PEAK HOUR INTERSECTION TURNING MOVEMENT VOLUMES
YEAR 1998

Level Of Service Description

Level Of Service (LOS) is defined as a qualitative measure describing operating conditions that include such factors as speed, travel time, maneuverability and safety. As noted in the 1985 "Highway Capacity Manual" (HCM) Special Report 209 by the Transportation Research Board there are six defined Levels Of Service with letter designations from "A" to "F". LOS "A" represents the best traffic operating characteristics with free flow conditions. LOS "F" describes the worst conditions or failing traffic operations with high levels of delay and or congestion experienced by motorists. These conditions are briefly described below for basic freeway segments, freeway weaving areas, ramp merges, and signalized and unsignalized intersections.

LOS Criteria For Basic Freeway Segments

For basic freeway segments, the density of the traffic stream based on the traffic volume demand and the available roadway capacity (number and width of available travel lanes) are the parameters used to define LOS. The densities used to define LOS are as follows:

Criteria for Basic Freeway Sections

LOS	Characteristics	* Density (passenger cars/ mile/lane)
A	Free flow, highest speed, highest maneuverability	≤12
B	Stable flow, high speed, high maneuverability	≤20
C	Stable flow, medium speeds, less maneuverability	≤30
D	Stable flow, medium speeds, high density	≤42
E	Unstable flow, low speeds, higher density	≤67
F	Breakdown in flow, stop-and-go speeds, highest density	>67

* Upper-Limit

LOS Criteria For Ramp Merges

The operational characteristics of ramp merges are dependent on the merge flow rate in passenger cars per hour (pcph) at the intersection point of the merging ramp and mainline roadway to which the ramp is merging. The merge flow rate is comprised of the ramp traffic and mainline roadway "lane 1" traffic volume. Lane 1 is the mainline roadway travel lane adjacent to the ramp merge and consequently the travel lane most impacted by the ramp merge effects. The HCM merge flow rate criteria used to define LOS include:

LOS Criteria for Ramp Merges

Level of Service	Merge Flow Rate (passenger cars/hour)
LOS A	≤ 650
LOS B	≤ 1050
LOS C	≤ 1500
LOS D	≤ 1800
LOS E	≤ 2000
LOS F	Widely Variable

LOS Criteria For Highway Weaving Areas

Highway weaving areas are defined as two or more traffic streams moving in the same general direction on a limited access roadway section which typically includes a ramp merge followed by a ramp diverge. The two traffic streams are composed of one stream entering from the mainline roadway upstream of the ramp merge and the second traffic stream entering from the ramp. Vehicles in both the upstream mainline roadway traffic flow and the ramp traffic flow may be destined for either the mainline downstream roadway or the off ramp. Vehicles entering from the ramp destined for the downstream mainline roadway are required to cross the path of vehicles from the upstream mainline roadway destined for the off ramp. One or both of the traffic streams are required to change travel lanes at least once to reach the appropriate downstream destination. The weaving area is the mainline roadway bordered by the ramp merge upstream and the ramp diverge downstream if within 2500 ft. The variables involved in determining the operational characteristics of a highway weaving area are the weaving area geometry as well as the number of lane changes required by both the upstream mainline roadway to access the off ramp, and the on ramp to access the downstream mainline roadway. The weaving area roadway profile grade, design speed and the heavy vehicle presence in the rightmost mainline roadway travel lane upstream of the ramp merge are also factors used to determine the operational characteristics of weaving areas.

The procedures described in the HCM and as implemented in the Highway Capacity Software (HCS) distributed by McTrans Center for the FHWA were used to evaluate the weaving areas located on the I-93 Northbound and Southbound mainline roadways located within the Design Contract D017A portion of the CA/T Project. The LOS results of the weaving analysis are expressed in terms of the travel speed of both the weaving and non-weaving vehicles travelling through the weaving area as described in the following table.

LOS Criteria for Highway Weaving Areas

LOS	Minimum. Avg. Weaving Speed (mph)	Minimum. Avg. Non-weaving Speed (mph)
A	55	60
B	50	54
C	45	48
D	40	42
E	35/30	35/30
F	<35/30	* <35/30

* 35 mph boundary used when comparing to computed speeds

LOS Criteria For Signalized Intersections

The LOS analysis for signalized intersections was performed using the Massachusetts Environmental Protection Agency (MEPA) approved "CINCH" software program. CINCH utilizes the operational analysis methodology of the 1985 HCM. The operational analysis of signalized intersections is an evaluation of the capacity of an intersection considering the details of traffic signal timing and phasing in addition to roadway geometry and related pedestrian activity given the traffic demand. It provides an assessment of whether or not the intersection capacity is likely to be exceeded for a given set of demand volumes and intersection geometry for the intersection as a whole and by intersection approach. The LOS results for signalized intersections analyzed using the CINCH program are expressed in terms of stopped delay per vehicle as described below:

Level of Service Criteria for HCM Operational Analysis

LOS	Characteristics	Stopped Delay per Vehicle (seconds)
A	Little or no delay, most vehicles do not stop at all.	5.0 or less
B	Short traffic delays, more vehicles stop than for LOS A causing higher average delay.	5.1 to 15.0
C	Average traffic delays. The number of vehicles stopping is significant, although many still pass through without stopping.	15.1 to 25.0
D	Long traffic delays. More vehicles stop on the average. Individual cycle failures become noticeable.	25.1 to 40.0

E	Very long traffic delays. LOS E is considered to be the limit of acceptable delay. Individual cycle failures are frequent.	40.1 to 60.0
F	Severe congestion. LOS F delay is considered to be unacceptable to most drivers. This condition often occurs with over-saturation, i.e., when arrival flow rates exceed the capacity of the intersection.	greater than 60.0

15.2 Highway Traffic Operations - Year 2010

The description of the highway operations for the roadways located within the Design Contract D017A limits has been subdivided into an I-93 Northbound Mainline section and an I-93 Southbound Mainline section. The discussion of LOS operating conditions for these major roadways with respect to basic freeway operations, weaving areas, ramp merges, and ramp diverges are described within the relevant major roadway section. The LOS operating conditions of the interim local roadway system constructed as part of Design Contract D017A are discussed separately within Section 15.3 of this report.

The Design Contract D017A study area I-93 mainline highway operating characteristics (traffic volumes, speeds and LOS) are shown in Table 15.1, Proposed Action, Design Contract D017A, I-93 Northbound Mainline and Southbound Mainline Highway Operations, Year 2010.

I-93 Northbound Mainline

As previously discussed, the I-93 Northbound mainline roadway within the existing Central Artery corridor originates south of Kneeland Street as a three lane roadway tunnel extending to the north under Atlantic Avenue to within the existing Central Artery roadway corridor just north of Summer Street. From Summer Street the I-93 Northbound mainline roadway maintains four travel lanes in a northerly orientation to south of the Design Contract D017A southerly limit at Congress Street. From Congress Street to Milk Street four travel lanes are maintained on the I-93 Northbound mainline roadway. Just south of Milk Street, the I-93 Northbound mainline roadway becomes a three lane roadway to approximately State Street where an additional lane is added. From State Street to North Street the I-93 Northbound mainline roadway has four travel lanes. North of the D017A study area limit at North Street an additional travel lane is added from the Sumner Tunnel, providing five travel lanes to the Charles River crossing of the I-93 Northbound mainline roadway.

Table 15.1:

Proposed Action Design Contract D017A

I-93 Northbound and Southbound Mainline Highway Operations

Year 2010

	Peak Hour Volumes		Peak Hour Speeds		Levels of Service	
	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
I-93 Northbound Mainline						
South of Off-Ramp CN-SA	7030	7820	40	33	E	E
Off-Ramp CN-SA north of I-93 (NB) diverge	2380	1830	**	**	**	**
North of Off-Ramp CN-SA	4650	5990	43	33	D	E
On-Ramp A-CN/RT	2040	2030	*	*	F~	F~
North of On-Ramp A-CN/RT	6690	8020	40	12	E	F
I-93 Southbound Mainline						
North of On-Ramp SA-CS	7330	6900	13	30	F	E
On-Ramp SA-CS north of I-93 (SB) merge	1680	1350	*	*	E	C
South of On-Ramp SA-CS	9010	8250	27	30	F	E
Off-Ramp CS-P south of I-93 (SB) diverge	1650	870	**	**	**	**
South of Off-Ramp CS-P	7360	7410	35	37	E	E

* Add lane to the I-93 Southbound mainline roadway.
** Off Ramp speed and LOS based on traffic conditions downstream of diverge from the I-93 Southbound mainline roadway.
~ LOS F conditions result from ramp capacity constraint, see description within text.

From approximately Hanover Street to the north side of the Charles River, the I-93 Northbound mainline roadway maintains a +5.0% roadway grade which generally speaking results in slower travel speeds and poorer LOS conditions than would be attained if the profile were level. The effects of this upgrade extend back to approximately State Street.

Within the Design Contract D017A study limits the I-93 Northbound mainline roadway begins as a four lane roadway within the existing Central Artery corridor at Congress Street and continues as four travel lanes to just south of Milk Street. In the vicinity of Milk Street a right-sided, one lane off Ramp CN-SA (Central Artery Northbound to Surface Artery) diverges from the I-93 Northbound mainline roadway to provide access to Cross Street and the Surface Artery southbound roadway at North Street. Ramp CN-SA is forecasted to carry 2380 vph in the AM peak hour and 1830 vph during the PM peak hour onto the local roadway system. Traffic operations where Ramp CN-SA intersects Cross Street and the Surface Artery (SB) at North Street controls traffic operations on Ramp CN-SA north of the I-93 Northbound diverge.

North of the Ramp CN-SA diverge, the I-93 Northbound mainline roadway continues as a three lane roadway section with a forecasted AM peak hour traffic volume of 4650 vph and an operating speed of 43 mph resulting in LOS D. During the PM peak hour, the forecasted traffic volume is 5990 vph with an operating speed of 33 mph and LOS E.

The I-93 Northbound mainline roadway is then joined by a left-side one lane on Ramp A-CN/R-T just north of the Ramp CN-SA diverge in the vicinity of State Street. The I-93 Northbound mainline roadway continues northerly as a four lane roadway section beyond the point where Ramp A-CN/R-T joins the I-93 Northbound mainline roadway. This is viewed as an "add-a-lane" situation within the HCM. Ramp A-CN/R-T has a forecasted AM peak hour and PM peak hour LOS of F resulting from the high volume of traffic accessing the I-93 Northbound mainline roadway on Ramp A-CN/R-T as discussed below. Ramp A-CN/R-T joins two separate on-ramps; Ramp A-CN and Ramp R-T (existing on ramp to the Central Artery northbound roadway within the Dewey Square Tunnel). Under the CA/T Project Proposed Action alignment, one lane Ramp R-T begins at the intersection of Essex and South Streets and continues in tunnel in a northerly direction paralleling the existing Dewey Square tunnel. Ramp R-T will be extended northerly by new tunnel construction to run parallel to and on the left side of the proposed I-93 Northbound Mainline roadway tunnel to just south of High Street. South of High Street, Ramp R-T is joined by one lane Ramp A-CN. Ramp A-CN is accessed on the local roadway system from the intersection of Atlantic Avenue and Northern Avenue continuing north to south of High Street where it merges with Ramp R-T. The merge with Ramp R-T and Ramp A-CN will occur in two lanes for approximately 500 feet and then continue to the I-93 Northbound mainline roadway

in one lane. The joint Ramp A-CN/R-T has a forecasted AM peak hour traffic volume of 2040 vph of which 1350 vph are from Ramp R-T. During the PM peak hour 2030 vph will access Ramp A-CN/R-T via Ramp R-T with 1010 vph entering from Ramp R-T. The Ramp A-CN merge with Ramp R-T is expected to generate a two lane queue of approximately 2000' during both the AM and PM peak hour. Approximately 60% of the queueing vehicles will be on Ramp R-T. The remaining 40% of the queueing vehicles will be on Ramp A-CN. Metering traffic destined for Ramp A-CN at the intersection of Northern Avenue and Atlantic Avenue is being considered, further studies are ongoing

North of the Ramp A-CN/R-T merge, the I-93 Northbound mainline has a forecasted traffic volume of 6690 vph with an operating speed of 40 mph and LOS E in the AM peak hour. During the PM peak hour, the forecasted traffic volume is 8020 vph with an operating speed of 12 mph and LOS F on the I-93 Northbound mainline roadway north of Ramp A-CN/R-T.

The I-93 Northbound mainline roadway continues northerly from State Street within the existing Central Artery corridor as a four lane roadway section to the Design Contract D017A limits at North Street. I-93 Southbound Mainline

The I-93 Southbound mainline roadway enters a tunnel section under Causeway Street as a five lane roadway section and continues in a southerly direction through the City of Boston within the existing Central Artery corridor. As with the I-93 Northbound mainline roadway, the I-93 Southbound mainline roadway enters the Design Contract D017A study area limits to the north of North Street.

At approximately New Chardon Street, a right-side one lane Ramp CS-CT (Central Artery Southbound to Callahan Tunnel) diverges from the I-93 Southbound mainline roadway. South of the I-93 Southbound mainline roadway diverge, Ramp CS-SA (Central Artery Southbound to Surface Artery) splits off from Ramp CS-CT.

Ramp CS-CT then continues as a one lane direct access ramp to the Callahan Tunnel and Ramp CS-SA provides access to the at-grade roadway system within Downtown Boston via the proposed intersection of the Surface Artery southbound roadway and Clinton Street. Ramp CS-CT has a forecasted AM peak hour traffic volume of 2140 vph just south of the I-93 Southbound mainline roadway diverge. Of these 2140 vehicles exiting the I-93 Southbound mainline roadway at Ramp CS-CT during the AM peak hour, 1300 vehicles are expected to access the local street system from Ramp CS-SA. During the PM peak hour, the forecasted traffic volume on Ramp CS-CT is 1530 vph with 580 vph travelling to Ramp CS-SA for access to the local street system. Traffic operations on Ramp CS-SA south of the Ramp CS-CT diverge are discussed within section 15.3 in reference to the local street intersection of Ramp CS-SA and Purchase Street. Traffic operations within Ramp CS-CT south of the Ramp CS-SA diverge are discussed in the Design Contract D015A contract documentation.

South of the Ramp CS-CT diverge, the I-93 Southbound mainline roadway continues as a four lane roadway with a forecasted traffic volume of 7330 vph in the AM peak hour and 6900 vph during the PM peak hour. Operating speeds of 13 mph during the AM peak hour and 30 mph in the PM peak hour are forecasted for the I-93 Southbound mainline roadway south of the Ramp CS-CT diverge. The resulting LOS during the AM and PM peak hour are LOS F and LOS E.

Accessed at New Chardon Street, Ramp SA-CS (Surface Artery southbound to Central Artery Southbound) with Ramp SA-CT (Surface Artery southbound to Callahan Tunnel) form an exit leg to the Surface Artery southbound roadway intersection at New Chardon Street within the Design Contract D015A limits. From New Chardon Street the Ramp SA-CS/Ramp SA-CT roadway continues in a southerly direction to where Ramp SA-CT diverges to the left to access the Callahan Tunnel. Ramp SA-CS continues southbound to the merge with the I-93 Southbound mainline roadway as a two lane ramp from the diverge with Ramp SA-CT. Ramp SA-CT traffic operations south of the Ramp SA-CS diverge are discussed in the Design Contract D015A contract documentation. Ramp SA-CS merges from two lanes to one lane before it joins the four lane I-93 Southbound Mainline roadway in the vicinity of North Street. From the Ramp SA-CS merge, the I-93 Southbound Mainline roadway continues as a five lane roadway within what is defined by the HCM and as discussed in Section 15.1 as, a "weaving area".

The I-93 Southbound weaving area is formed by the Ramp SA-CS merge to the north and the Ramp CS-P (Central Artery Southbound to Purchase Street) diverge to the south on the I-93 Southbound mainline roadway. The Ramp CS-P diverge from the I-93 Southbound Mainline roadway occurs just south of State Street. Ramp SA-CS is forecasted to carry 1680 vph in the AM peak hour and 1350 vph during the PM peak hour to the I-93 Southbound mainline roadway. From two lane Ramp CS-P, 1650 vph and 870 vph are forecasted to exit the I-93 Southbound Mainline roadway during the AM and PM peak hour, respectively. Operating conditions within the I-93 Southbound Mainline roadway between Ramp SA-CS and CS-P during the AM peak hour are LOS F with travel speeds of 27 mph. During the PM peak hour LOS E operating conditions with travel speeds of 30 mph are expected on this section of the I-93 Southbound Mainline roadway. The forecasted AM and PM peak hour volumes forecasted are 9010 vph and 8250 vph, respectively. South of the Ramp CS-P diverge at State Street the I-93 Southbound Mainline roadway continues in a southerly direction as a four lane roadway to High Street. Between State and High Street, the I-93 Southbound Mainline roadway has a forecasted traffic volume of 7360 vph, travel speed of 35 mph and LOS E during the AM peak hour. During the PM peak hour the volume of traffic forecasted for the I-93 Southbound Mainline roadway between State and High Street is 7410 vph. LOS E traffic operations and travel speeds of 37 mph are expected on this section of roadway during the PM peak hour.

One lane Ramp R-R diverges from the I-93 Southbound Mainline roadway at High Street which is the I-93 Southbound Mainline roadway Design Contract D017A southerly limit. Ramp R-R is the existing Central Artery off ramp to Purchase Street reconstructed to access the proposed I-93 Southbound Mainline tunnel. Ramp R-R has a forecasted AM peak hour traffic volume of 1460 vph and PM peak hour traffic volume of 1110 vph. Traffic operations on Ramp R-R south of the I-93 Southbound Mainline roadway diverge are discussed in reference to the local street intersection of Summer and Purchase Streets within Design Contract D018A documentation

15.3 Surface Street Intersections

As a part of the I-93 Northbound and Southbound Mainline tunnel and ramp construction, a northbound and southbound surface arterial street system will be created that will extend from Kneeland Street to Causeway Street and be integrated with the City's local street system. The surface arterial street system is composed of both existing city streets and new surface streets to provide the necessary continuity between Kneeland Street and Causeway Street. Access between the I-93 Northbound and Southbound Mainline ramps and the surface arterial street system is also an integral objective of the surface arterial street system.

All of the adjacent intersections on the proposed northbound and southbound surface arterial roadway are generally considered sensitive to queueing and traffic signal coordination problems. Where there is a high potential for adverse queuing impacts resulting from excessive delays at adjacent intersections or the close spacing of two adjacent intersections as in the case of diamond type interchanges, the "PASSER-III-88" method of analysis for the Year 2010 AM and PM peak hour was used. PASSER-III-88 is a traffic engineering software package developed by the Texas Department of Highways and Public Transportation to analyze permitted or traffic responsive, fixed sequence signalized diamond interchanges. Although some closely spaced local street intersections do not create a "true" diamond interchange, this software analysis methodology best addresses the impacts of vehicles queueing through adjacent intersections and the traffic signal synchronization that would be required between the intersections. The results of the 2010 AM and PM peak hour PASSER-III-88 analysis and intersection planning method analysis are discussed within the I-93/Central Artery Central Area Traffic Report. Roadway geometry changes required to improve traffic operations between two adjacent intersections have been performed based on the PASSER-III-88 analysis results. The HCM planning method analysis of the 2010 AM and PM peak hour traffic volumes is also discussed within the I-93/Central Artery Traffic Report. The 1998 AM and PM peak hour LOS analysis results for the surface roadway intersections included within Design Contract D017A were obtained by using the signalized intersection capacity analysis methodology based on the 1985 HCM

criteria discussed in section 15.1. Intersections analyzed by the signalized intersection capacity analysis methodology assume that the intersection is either isolated or not close enough to affect a nearby upstream or downstream intersection. The AM and PM peak hour traffic volumes generated for the year 1998 were used to determine the sequencing of traffic movements within each intersection upon removal of the existing Central Artery viaduct structure within Downtown Boston.

The results of the 1998 AM and PM peak hour signalized intersection analysis located within the CA/T Project Design Contract D017A limits are shown in Table 15.2, Proposed Action Design Contract D017A, Signalized Intersection Level of Service Analysis, Year 1998.

Table 15.2:
Proposed Action Design Contract D017A
Signalized Intersection Levels of Service Analysis
Year 1998

Intersection	APPROACH	AM Peak Hour AVG. DELAY (sec)	AM Peak Hour LOS	PM Peak Hour AVG. DELAY (sec)	PM Peak Hour LOS
Atlantic Avenue at	EB	32.3	D	20.0	C
Northern Avenue/Ramp A-CN	WB	38.1	D	34.2	D
	NB	25.5	D	21.7	C
INTERSECTION		31.3	D	22.8	C
Atlantic Avenue at	EB	28.6	D	29.2	D
High Street	NB	2.7	A	3.8	A
INTERSECTION		5.7	B	7.5	B
Atlantic Avenue at	EB	12.5	B	22.7	C
East India Row	WB	15.4	C	21.0	C
	NB	9.4	B	4.8	A
INTERSECTION		10.4	B	7.2	B
Atlantic Avenue at	EB	18.5	C	18.2	C
Milk Street	NB	5.6	B	8.1	B
INTERSECTION		9.7	B	11.9	B
Atlantic Avenue at	WB	29.7	D	23.7	C
State Street	NB	7.1	B	14.6	B
INTERSECTION		9.7	B	16.4	C
Cross Street	EB	19.6	C	28.0	D
at Atlantic Avenue	WB	19.6	C	28.0	D
	NB	6.0	B	10.9	B
INTERSECTION		11.0	B	16.5	C
Surface Artery (SB) at					
Ramp CS-SA/Clinton Street	WB	30.08	D	20.5	C
and the Walk To The Sea	SB	12.92	B	21.3	C
INTERSECTION		15.80	C	21.0	C
Surface Artery (SB)	WB	31.5	D	30.6	D
at State Street	SB	3.8	A	6.8	D
INTERSECTION		5.0	B	9.7	B
Surface Artery (SB)	EB	31.5	D	28.5	D
at Milk Street	SB	1.1	A	3.5	A
INTERSECTION		2.4	A	6.6	B
Surface Artery (SB)	EB	15.8	C	12.4	B
at Broad Street	WB	14.6	B	10.7	B
	SB	8.7	B	15.4	C
INTERSECTION		10.7	B	13.9	B
Purchase Street	EB	25.4	D	27.5	D
at High Street	SB	2.3	A	3.0	A
INTERSECTION		4.9	A	6.0	B

15.4 Traffic Signal Warrants

Traffic signal warrant studies determine the necessity for signalizing the intersections located within the CA/T Project Design Contract D017A study limits. The traffic signal warrants evaluated are based on the 1988 FHWA Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) signal warrant justification requirements. The MUTCD signal warrant justification evaluates intersection operations in terms of eleven different criteria in order to ascertain if a traffic signal is required. The installation of a traffic signal can be considered required when one or more MUTCD traffic signal warrants are met. The evaluation is based on intersection traffic volume data, existing traffic controls, pedestrian traffic flow volume data, accident data, local environmental conditions, and traffic peaking factors. The eleven traffic signal warrant evaluations discussed within the MUTCD include:

Warrant 1 - Minimum vehicular volume
Met when traffic volumes at the intersection major and minor street meet or exceed the criteria listed within the MUTCD during the same eight hours of an "average" day.

Warrant 2 - Interruption of continuous traffic
Met when the traffic volumes on the major street are excessive and traffic entering from the minor street is expected to experience excessive delay and or hazards. MUTCD lists major and minor street volume criteria required over an eight hour period of an "average" day.

Warrant 3 - Minimum pedestrian volume
Met when intersection or mid-block pedestrian crossing volumes exceed criteria specified in MUTCD.

Warrant 4 - School crossings
Satisfied when a determination is made that gaps in traffic are not sufficient to allow for the number and size of groups of school children at the school crossing.

Warrant 5 - Progressive movement
Met upon determination that providing a traffic signal will allow for better traffic flow or traffic progression within the traffic stream.

Warrant 6 - Accident experience
Generally met when accident frequency criteria shown in MUTCD is satisfied.

Warrant 7 - Systems
Met when traffic flow volumes during the peak hour exceed 1000 vehicles in addition to meeting Warrants 1, 2, 8, 9 and 11 during particular time periods.

Warrant 8 - Combination of warrants
Met when eighty percent of the criteria listed in Warrants 1 and 2 are satisfied.

Warrant 9 - Four Hour Volumes
Satisfied when the traffic volumes listed in the MUTCD are met over a four hour period.

Warrant 10 - Peak Hour Delay (measured in the field)
Satisfied when due to extreme delay experienced on the minor street approach to a major roadway the criteria for delay is met and traffic volumes on the minor street exceed the limitations listed within the MUTCD.

Warrant 11 - Peak Hour Volume
Met when the traffic volumes on the minor street and major street approaches to an intersection are in excess of the volumes shown in the MUTCD over a one hour period.

Traffic signal warrant analysis on intersections being designed is generally performed using data for the Year 1998 "opening day" traffic flow conditions. Within the CA/T Project Design Contract D017A limits, the five signal warrant thresholds pertaining to vehicular traffic flow (Warrants 1, 2, 8, 9, and 11) have been fully evaluated using the CA/T Project 1998 TRANPLAN traffic modelling network. The results of the traffic signal warrant analysis performed for the intersections located within the Design Contract D017A limits are shown in Table 15.3, Proposed Action Design Contract D017A Vehicular Signal Warrant Analysis, Year 1998.

As shown in Table 3, all but one of the eleven intersections located within the Design Contract D017A limits met at least one of the vehicular signal warrants evaluated. The intersection of East India Row at Atlantic Avenue does not warrant a traffic signal based on vehicular traffic flow forecasted for the year 1998. A review of existing pedestrian traffic flow across Atlantic Avenue at East India Row indicates that a traffic signal is warranted at this location as a result of meeting Warrant 3 discussed above. The existing pedestrian count data used to evaluate Warrant 3 at the intersection of East India Row at Atlantic Avenue was collected as part of the Central Artery (I-93)/Tunnel (I-90) Project "Traffic and Pedestrian Counts in Support of D014 Section Design Contracts, Draft Final Report, Summer and Fall Counts - 1990 prepared in November 1990.

Table 15.3:

Proposed Action Design Contract D017A
Vehicular Signal Warrant Analysis
Year 1998

Intersection	Vehicular Signal Warrant 1	2	8	9	11
Atlantic Avenue at Northern Avenue/Ramp A-CN	met	-	met	met	met
Atlantic Avenue at High Street	-	-	-	met	-
Atlantic Avenue at East India Row	-	-	-	-	-
Atlantic Avenue at Milk Street	met	-	met	met	met
Atlantic Avenue at State Street	met	met	met	met	met
Cross Street at Atlantic Avenue	met	-	met	met	met
Surface Artery (SB) at Ramp CS-SA/Clinton Street and the Walk To The Sea	met	met	met	met	met
Surface Artery (SB) at State Street	met	met	met	met	met
Surface Artery (SB) at Milk Street	-	met	met	met	met
Surface Artery (SB) at Broad Street	met	-	met	met	-
Purchase Street at High Street	-	-	-	met	-

- Indicates traffic signal vehicular warrant was not met

Consequently, all of the intersections listed in Table 3 will be designed with traffic signal control equipment as shown on the Traffic and Transportation drawings within the D017A Preliminary Design Submittal.

The local street system traffic control equipment utilized within the Design Contract D017A limits should be designed and constructed in accordance with Boston Transportation Department (BTD) criteria. The operations and maintenance of all local street system traffic control equipment will be assumed by the BTD through a Traffic Control Agreement with the MDPW upon completion of the CA/T Project within the Design Contract D017A limits. In addition to the traffic control equipment shown within the Design Contract Preliminary Design Submittal drawings on the local street system, system detectors should also be placed on Ramp CS-SA approximately 400 feet upstream of the intersection with Surface Artery (SB) roadway.

Within the CA/T Project Proposed Action Design Contract D017A limits an interim phase surface arterial street system correlated with construction staging is required to provide local street access to the I-93 mainline roadway until such time as all final design project elements are operational. These interim phase local street system designs will be operational until the completion of all construction related activities within the Congress Street to North Street limits. The opening of the I-93 Northbound mainline roadway tunnel prior to the I-93 Southbound mainline roadway tunnel and the removal of the existing Central Artery viaduct between Congress Street and North Street are the final construction activities in this area and the last impediment to the implementation of all final design roadway elements. Wherever possible however, the local street system interim phase designs should include elements of the final design if the existence and removal of the existing Central Artery viaduct is not perceived as a conflict. The surface street restoration which includes all urban design elements such as street furniture, landscaping and finish materials will occur within the Design Contract D017C scope of work following the construction of the D017A local street alignment.

16.0 Environmental Issues

Environmental issues associated with construction of the Central Artery (I-93) mainline and ramps are discussed in the Final Supplemental Environmental Impact Statement/Report (FSEIS/R). Additionally, the Supportive Engineering Report (SER), an appendix to the FSEIS/R, discusses this section of the project in more detail in Chapter 3, Central Area. Chapter 3, Central Area. Chapter 3 (SER) provides information on utility relocations and right-of-way, geotechnical issues, tunnel ventilation and construction sequencing. Massachusetts Department of Public Works commitments affecting design and/or construction of this section of the Central Artery are summarized below. Those commitments must be reflected in appropriate contractual documents and must be implemented.

The Central Artery in this area will be a continuous tunnel network, inclusive of I-93 mainline roadways and various ramps which provide connections to surface roadways and to the Sumner and Callahan tunnels. Northbound, southbound, and interconnection traffic will be accommodated within separate unidirectional tunnel boxes, one to four lanes wide.

Ventilation building #3 may be a component of a joint development facility at the Boston Edison substation site, but with most functional elements of the ventilation system located below grade. Exhaust shafts and fresh air intakes may be integral to any commercial superstructure above.

Therefore, major environmental issues associated with below grade roadway and building construction are tunnel construction techniques, excavated materials transport and disposal, and maintenance of surface activities. Major underlying objectives regarding maintenance of surface arteries are:

- To retain, essentially, full use of the existing Central Artery lanes until the Artery tunnel is completed; to replace movements with temporary ramps before they are closed, insofar as possible

- To retain, essentially, full use of the existing Surface Artery, Atlantic Avenue and side streets by decking over tunnel sections

- To retain use of the Sumner and Callahan tunnels during construction and to tie the tunnels into the new Artery tunnel after the opening of the Third Harbor Tunnel.

16.1 Excavation Methods

Tunnels are the principal type of structures to be built in this contract area. Tunnel sections will be primarily constructed using cut-and-cover methods with slurry wall or soldier pile tremmie concrete support walls. Cut-and-cover tunnel construction involves excavation of earth materials between

roughly parallel support walls, cast-in-place tunnel structure construction, backfilling and surface restoration.

The following Department commitments concerning construction excavation methods are made in the FSEIS/R:

- To support excavations and structures with bracing and shoring methods designed to resist lateral pressures caused by soils and groundwater loadings and surcharges from adjacent structures in the clay and fill materials encountered

- To monitor excavation support walls and structural movements through an instrumentation and field survey program designed to record unusual deformation patterns and trigger pre-planned remedial measures, as needed

- To hold construction contractors responsible for cosmetic damages incurred during construction, and to conduct pre-construction surveys to determine baseline conditions.

16.2 Transportation and Disposal of Excavated Materials

Transportation of excavated materials from the contract area will be by truck over the project right-of-way or temporary haul roads, to the extent possible. Delivery of materials to final disposal locations will require use of either truck, rail and/or barge:

- To transport materials suitable for marine disposal to Drydock #3 in the Boston Marine Industrial Park (BMIP) in South Boston

- To transport historic fill, unsuitable for beneficial reuse, to Commonwealth Flats in South Boston for disposal within the project right-of-way over construction haul roads

- To beneficially reuse suitable historic fill, till and marine clays for project backfill, daily landfill cover or capping, as appropriate

- To reclaim excavated materials (especially metals, brick and concrete) as possible based on cost/logistical considerations

- To use ten-wheel dump trucks to move material on a three-shift-per-day basis during peak construction periods

- To remove any hazardous material, previously identified, in advance of project construction by the Department's Right-Of-Way Assessment and Remediation Services (ROWARS) consultant to appropriate disposal locations

- To develop a comprehensive set of operational procedures to guide the Department and its contractors in the conduct of assessment, characterization, design and remediation under M.G.L. Chapter 21 E (i.e., Massachusetts Oil and Hazardous Material Release Prevention and Response Act).

16.3 Mitigation Commitments

The Department has made the following additional commitments:

- To consider use of noise abatement measures for areas or land uses where traffic-related noise substantially exceeds existing noise levels

- To consider use of alternative traffic routes and various demand management measures for downtown commuter traffic

- To prohibit delivery truck idling during inactive periods and to study off-peak truck deliveries for this contract area

- To mitigate fugitive dust emissions with traditional control measures, and to employ special controls for asbestos and lead-based paint emissions

- To develop specifications for maintenance of pedestrian circulation in construction contracts

- To make temporary construction design elements as compatible as possible with physical surroundings and to involve neighborhood residents in review and comment opportunities

- To require contractors to maintain clean work environments during construction

- To implement rodent, cockroach and odor control programs for the contract area

- To institute a program to identify and consider measures to address unanticipated events during construction and to monitor relevant construction and environmental activities

- To conduct Phase III archaeological investigations at three sites near the North End to retrieve significant historical information which will be reviewed by the public and the State Historic Preservation Officer before project construction.

16.4 Environmental Permits

Permits, approvals and/or reviews may be required for the contract area tunnels, utility work and ventilation buildings. The Section Design Consultant's role will be to provide necessary technical information for permit applications. Those applications will be prepared by a subcontractor to the

management consultant. Needed permits, approval and/or reviews may include:

- A Sewer System Extension and Connection Permit from the Massachusetts Department of Environmental Protection (DEP), Division of Water Pollution Control (DWPC), in coordination with the Boston Water and Sewer Commission (BWSC), to authorize new connections to sanitary sewer systems

- A Federal Consistency Review from the Massachusetts Coastal Zone Management Agency

- A Chapter 91 License from the DEP, Division of Wetlands and Waterways Regulation (DWWR) for construction in historic filled tidelands or flowed tidelands.

- Various additional permits, approval or reviews from the City of Boston. These include special permits from BWSC for various kinds of water and hydrant connections, dewatering of excavations (if necessary), and related matters; and a construction management plan for the Boston Transportation Department.

17.0 Construction Staging and Schedule

17.1 Construction Sequencing: Assumptions

- All six lanes of the existing Central Artery will remain open until the new depressed Artery is completed. On- and off- ramp movements will be replaced with temporary ramps before they are closed, wherever possible.

- By decking over the proposed tunnel sections, the Surface Artery below the existing Central Artery as well as Atlantic Avenue and all cross streets in the Central Area also will remain open to the maximum extent possible.

- The Sumner and Callahan Tunnels remain open during construction, and final tie-in work in the portal areas will not take place until the new Third Harbor Tunnel is open.

- This sequencing includes Design Contracts D011A, D017A and D015A.

17.2 Selected Methods and Techniques

Tunnels are the principal types of structures to be built in the Central Area. The tunnel sections will be constructed primarily by the cut-and-cover method with slurry wall or soldier pile tremmie concrete (SPTC) support walls. The existing elevated Central Artery will be underpinned by placing transverse beams on intermediate caisson supports between slurry walls or bear directly on the slurry or SPTC walls. Longitudinally oriented transfer beams supported by the transverse beams will attach to and support the Artery columns. The Red Line South Station tunnel will be underpinned using a jacked-pipe roof method. At the intersection of the Blue Line tunnel and the proposed mainline tunnel, the latter will be supported on slurry or SPTC walls constructed on both sides of the Blue Line tunnel. A shared slab will be constructed as the floor of the proposed mainline tunnel and as the ceiling of the proposed expanded MBTA Aquarium Station. The slurry or SPTC walls will support the weight from the proposed tunnel segment and become a permanent part of the expanded Blue Line Station. The work at the Blue Line crossing will be accomplished by the MBTA during their contract to remodel and expand service at the MBTA Aquarium Station.

17.3 Maintenance of Traffic/Construction Staging

17.3.1 Stage 1 (See Figure 17.1)

Early construction activities in the Central Area will consist of the relocation of certain utilities, the construction of the parking structure on Parcel 7. Utility relocation work in Atlantic Avenue will entail the removal of the northbound on-ramp from Northern Avenue to permit maintenance of surface traffic around the construction area.

Mainline tunnel construction will begin on the east side of the Artery corridor between Northern Avenue and North Street, and on both sides between North and Causeway Streets. Work will include excavation support construction; surface decking installation; underpinning the Central artery, transit facilities, and adjacent structures; temporary ramp relocations; excavation and bracing; and tunnel construction. Removal of a portion of the Federal Reserve Building parking structure to permit construction of the northbound tunnel just north of Summer Street also will be performed during this stage.

Temporary replacement ramps will be constructed at the following locations: the northbound off-ramp to the Callahan Tunnel, the northbound on-ramp from the Sumner Tunnel the southbound off-ramp to New Chardon Street, the southbound on-ramp from New Sudbury Street, and the southbound off-ramp to North Street. The Northbound off-ramp to Causeway Street will be removed during this stage.

17.3.2 Stage 2 (See Figure 17.2)

Following the opening of the temporary ramps indicated in Stage 1, the northbound off-ramp to the Callahan tunnel will be rebuilt in place.

Following decking of the east side of the Artery corridor, traffic will be shifted from the Surface Artery to Atlantic Avenue, and slurry wall construction, underpinning of the west side of the existing Artery, and surface decking on the west side will begin. Mainline tunnel construction will continue (below decking on the east side).

17.3.3 Stage 3 (See Figure 17.3)

Tunnel construction, including the northbound off-ramp CN-SA, the northbound on-ramp ST-CN, and the northbound on-ramp A-CN will be in full progress with concentration on the northbound side. construction of ventilation buildings 3 and 4 will be initiated.

Construction of portions of southbound off-ramps CS-CT, CS-SA, and CS-P and on-ramps SA-CS and SA-CT will be under construction. As the northbound roadway nears completion later in this stage, one-half of the Sumner Tunnel approach will be closed and reconstructed to complete its connection to the new northbound roadway. In addition, the rebuilt northbound off-ramp to the Callahan Tunnel will be removed to enable the opening of the CN-SA ramp when the northbound roadway is opened.

17.3.4 Stage 4 (See Figure 17.4)

Traffic will be diverted to the new depressed Central Artery northbound, while Artery southbound traffic will be moved to the northbound side of the existing roadway south of North Street.

With the traffic diverted, construction of the transition portion of the southbound roadway, including Ramp CS-P, between International Place and Congress Street, will be initiated. Improvements to the western half of the Dewey Square tunnel will also be performed.

Portions of the existing Artery and temporary ramps no longer in service will be removed. The remaining portions of southbound Ramps CA-SB, CS-CT, SA-CS, and SA-CT will be constructed. Also, the Callahan Tunnel approach will be constructed to complete the CS-CT connection.

17.3.5 Stage 5 (See Figure 17.5)

Southbound traffic will be diverted to the new depressed Central Artery southbound and the western half of the Dewey Square tunnel. With traffic now on this side of the Dewey Square tunnel and transition segment, the remainder of the southbound tunnel, including counterflow Ramp R-T and Ramp A-CN and improvements to the east side of the Dewey Square tunnel will be completed. With all traffic off the existing elevated Artery, the remainder of the existing structure, including underpinning supports and temporary ramps, can be removed. Following removal, tunnel backfill and surface restoration work will be performed. Remaining ramp work, including ST-SA and RT, will be completed and the ramps opened during this stage. Following completion of the work in the Dewey Square tunnel and transition section, all remaining roadway required to complete the project will be opened.

17.4 Temporary Structures

Other than the temporary on- and off-ramps, and decking of the Surface Artery over the depressed Central Artery, no major temporary structures are anticipated.

17.5 Staging Areas

The contractors' staging and laydown areas will be located in the vicinity of the proposed alignment in the right-of-way, at 150 Causeway Street, on Metropolitan District Commission (MDC) property in the north, on Parcel 7 in the Haymarket Area, and at the Boston Edison site in the south. Fencing security, and maintenance of these areas will be the responsibility of the contractors under the supervision of the Department's management consultant. The Guilford property, discussed in Chapter 20 of the SEIS/R, also is being considered as a staging area.

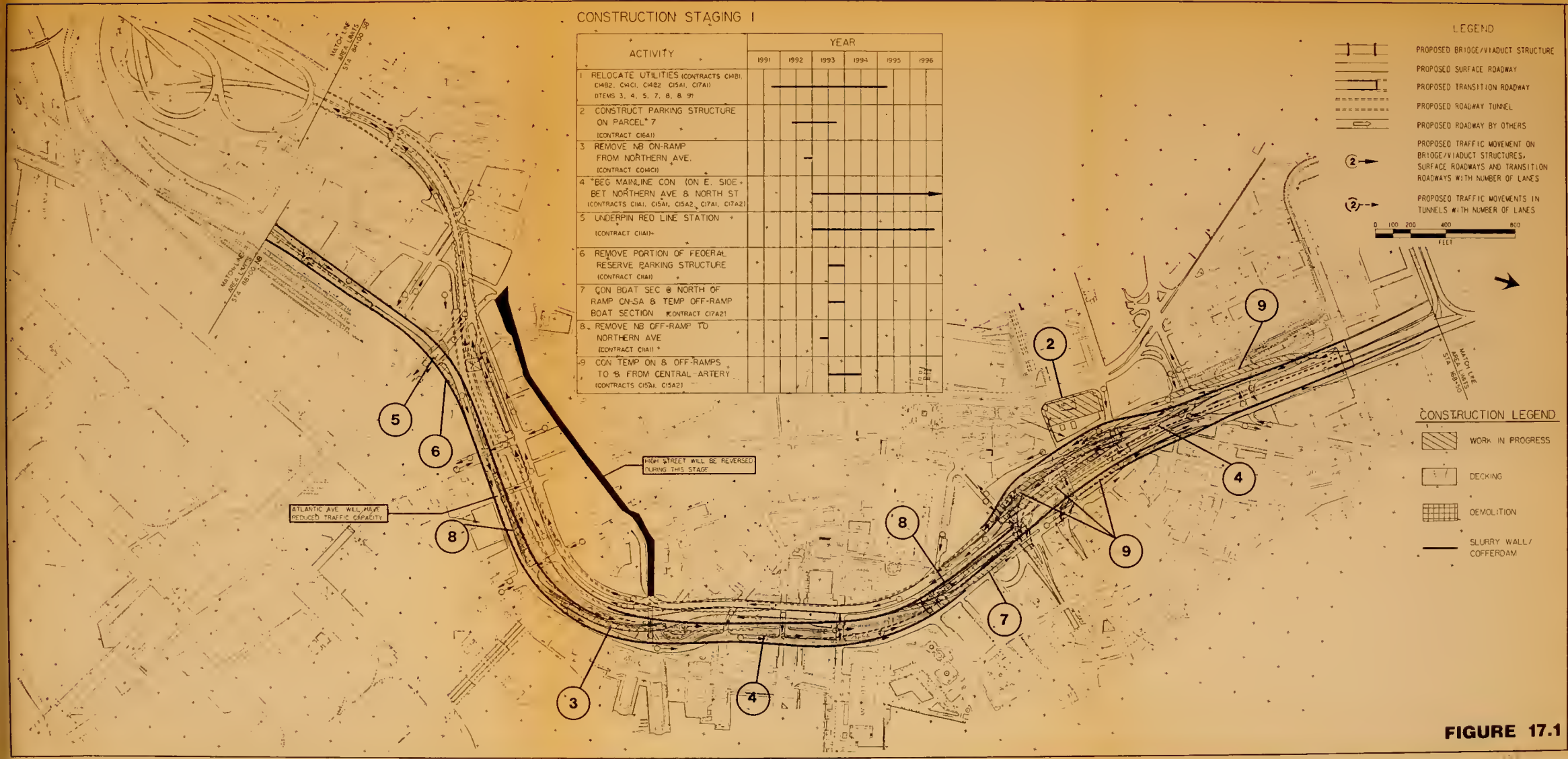
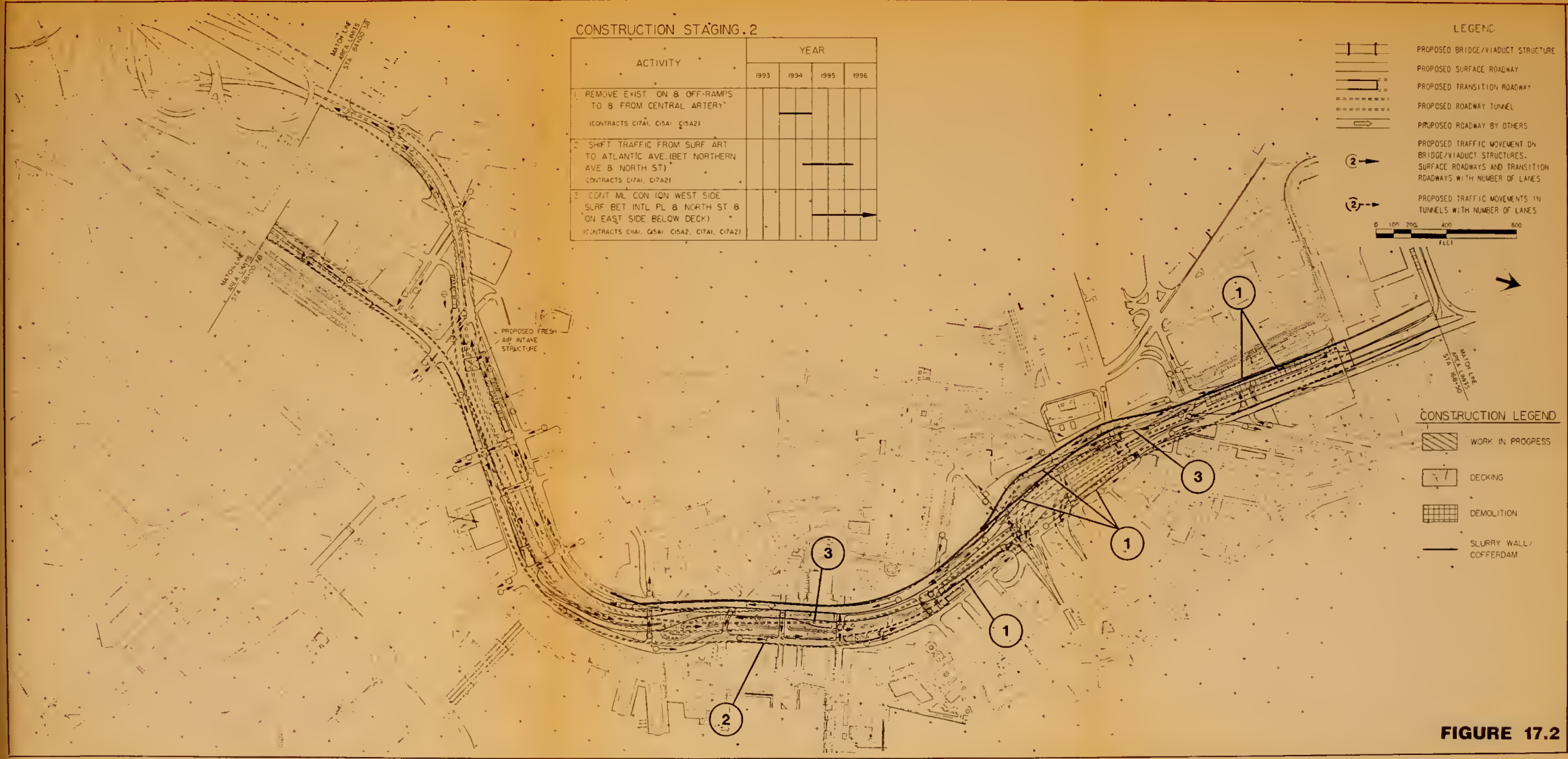

CONSTRUCTION STAGING I
ACTIVITY
YEAR
1991
1992
1993
1994
1995
1996
1 RELOCATE UTILITIES (CONTRACTS C14B1, C14B2, C14C1, C14B2 C15A1, C17A1) (ITEMS 3, 4, 5, 7, 8, & 9)
2 CONSTRUCT PARKING STRUCTURE ON PARCEL 7 (CONTRACT C16A1)
3 REMOVE NB ON-RAMP FROM NORTHERN AVE. (CONTRACT C014C1)
4 BEG MAINLINE CON (ON E. SIDE) BET NORTHERN AVE & NORTH ST (CONTRACTS C11A1, C15A1, C15A2, C17A1, C17A2)
5 UNDERPIN RED LINE STATION (CONTRACT C11A1)
6 REMOVE PORTION OF FEDERAL RESERVE PARKING STRUCTURE (CONTRACT C11A1)
7 CON BOAT SEC @ NORTH OF RAMP CN-SA & TEMP OFF-RAMP BOAT SECTION (CONTRACT C17A2)
8 REMOVE NB OFF-RAMP TO NORTHERN AVE (CONTRACT C11A1)
9 CON TEMP ON & OFF-RAMPS TO & FROM CENTRAL ARTERY (CONTRACTS C15A1, C15A2)
LEGEND
PROPOSED BRIDGE/VIADUCT STRUCTURE
PROPOSED SURFACE ROADWAY
PROPOSED TRANSITION ROADWAY
PROPOSED ROADWAY TUNNEL
PROPOSED ROADWAY BY OTHERS
PROPOSED TRAFFIC MOVEMENT ON BRIDGE/VIADUCT STRUCTURES, SURFACE ROADWAYS AND TRANSITION ROADWAYS WITH NUMBER OF LANES
PROPOSED TRAFFIC MOVEMENTS IN TUNNELS WITH NUMBER OF LANES
0 100 200 400 800
FEET
CONSTRUCTION LEGEND
WORK IN PROGRESS
DECKING
DEMOLITION
SLURRY WALL/ COFFERDAM
MATCH LINE AREA LIMITS STA 84+00
MATCH LINE AREA LIMITS STA 88+50
HIGH STREET WILL BE REVERSED DURING THIS STAGE
ATLANTIC AVE WILL HAVE REDUCED TRAFFIC CAPACITY
THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
CENTRAL ARTERY II-93I/TUNNEL II-90I PROJECT
SEIS/R SUPPORTIVE ENGINEERING REPORT

FIGURE 17.1


CONSTRUCTION STAGING.2
ACTIVITY
YEAR
1993
1994
1995
1996
1. REMOVE EXIST ON & OFF-RAMPS TO & FROM CENTRAL ARTERY (CONTRACTS C17A1, C15A1, C15A2)
2. SHIFT TRAFFIC FROM SURF ART TO ATLANTIC AVE. (BET NORTHERN AVE & NORTH ST) (CONTRACTS C17A1, C17A2)
3. CONT ML CON ION WEST SIDE SURF BET INTL PL & NORTH ST & ON EAST SIDE BELOW DECK) (CONTRACTS C11A1, C15A1, C15A2, C17A1, C17A2)
LEGEND
PROPOSED BRIDGE/VIADUCT STRUCTURE
PROPOSED SURFACE ROADWAY
PROPOSED TRANSITION ROADWAY
PROPOSED ROADWAY TUNNEL
PROPOSED ROADWAY BY OTHERS
PROPOSED TRAFFIC MOVEMENT ON BRIDGE/VIADUCT STRUCTURES, SURFACE ROADWAYS AND TRANSITION ROADWAYS WITH NUMBER OF LANES
PROPOSED TRAFFIC MOVEMENTS IN TUNNELS WITH NUMBER OF LANES
0 100 200 400 800
FEET
PROPOSED FRESH AIR INTAKE STRUCTURE
CONSTRUCTION LEGEND
WORK IN PROGRESS
DECKING
DEMOLITION
SLURRY WALL/ COFFERDAM
1
2
3

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
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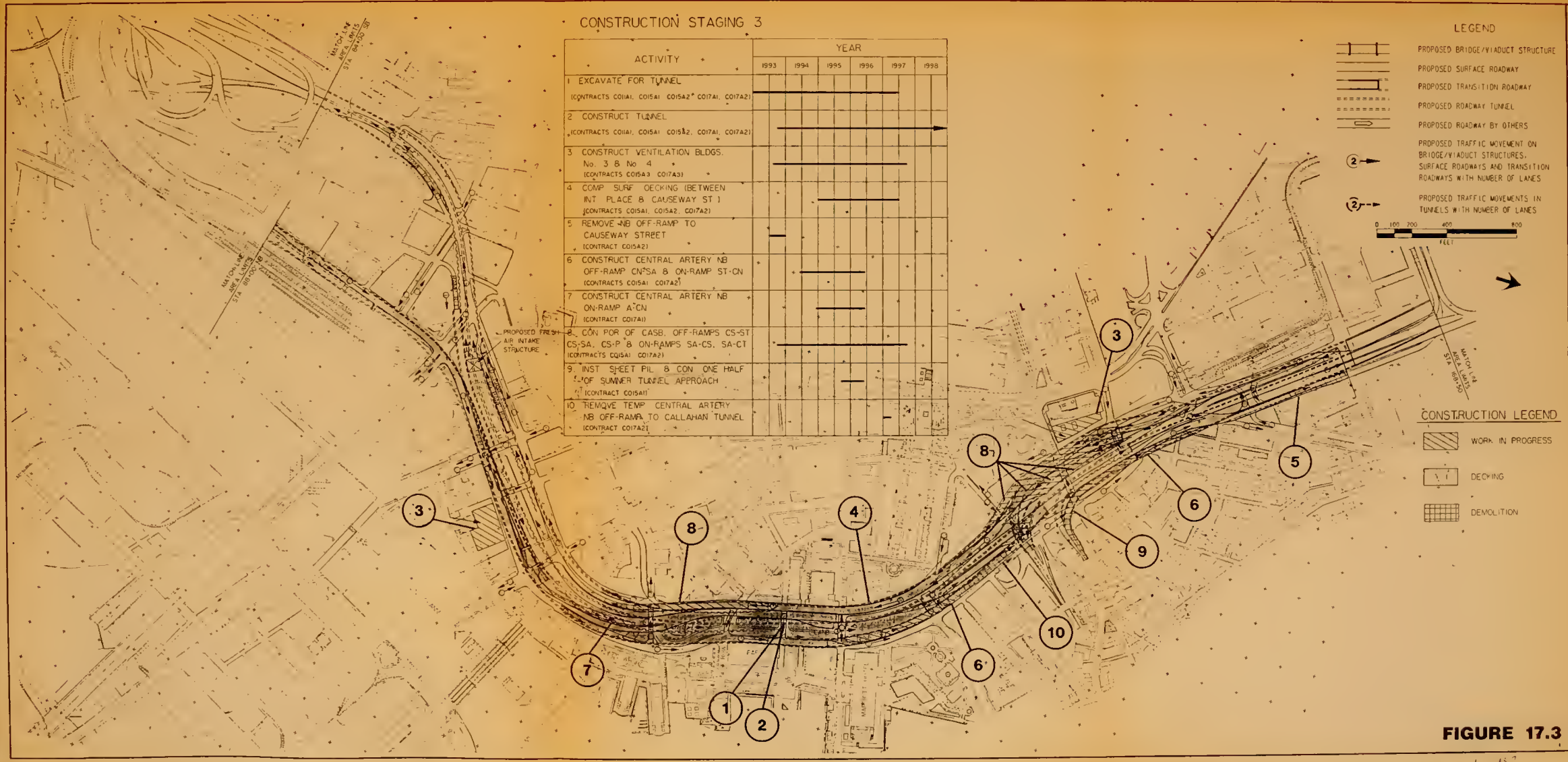
SEIS/R SUPPORTIVE ENGINEERING REPORT

FIGURE

FIGURE 17.2

CONSTRUCTION STAGING 3

ACTIVITY	YEAR 1993	1994	1995	1996	1997	1998
1 EXCAVATE FOR TUNNEL (CONTRACTS C011A1, C015A1 C015A2* C017A1, C017A2)						
2 CONSTRUCT TUNNEL (CONTRACTS C011A1, C015A1 C015A2, C017A1, C017A2)						
3 CONSTRUCT VENTILATION BLDGS. No. 3 & No. 4 (CONTRACTS C015A3 C017A3)						
4 COMP SURF DECKING (BETWEEN INT PLACE & CAUSEWAY ST.) (CONTRACTS C015A1, C015A2, C017A2)						
5 REMOVE NB OFF-RAMP TO CAUSEWAY STREET (CONTRACT C015A2)						
6 CONSTRUCT CENTRAL ARTERY NB OFF-RAMP CN-SA & ON-RAMP ST-CN (CONTRACTS C015A1 C017A2)						
7 CONSTRUCT CENTRAL ARTERY NB ON-RAMP A-CN (CONTRACT C017A1)						
8 CON POR OF CASB, OFF-RAMPS CS-ST CS-SA, CS-P & ON-RAMPS SA-CS, SA-CT (CONTRACTS C015A1 C017A2)						
9 INST SHEET PIL & CON ONE HALF OF SUMNER TUNNEL APPROACH (CONTRACT C015A1)						
10 REMOVE TEMP CENTRAL ARTERY NB OFF-RAMP TO CALLAHAN TUNNEL (CONTRACT C017A2)						



THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
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SEIS/R SUPPORTIVE ENGINEERING REPORT

FIGURE

FIGURE 17.3

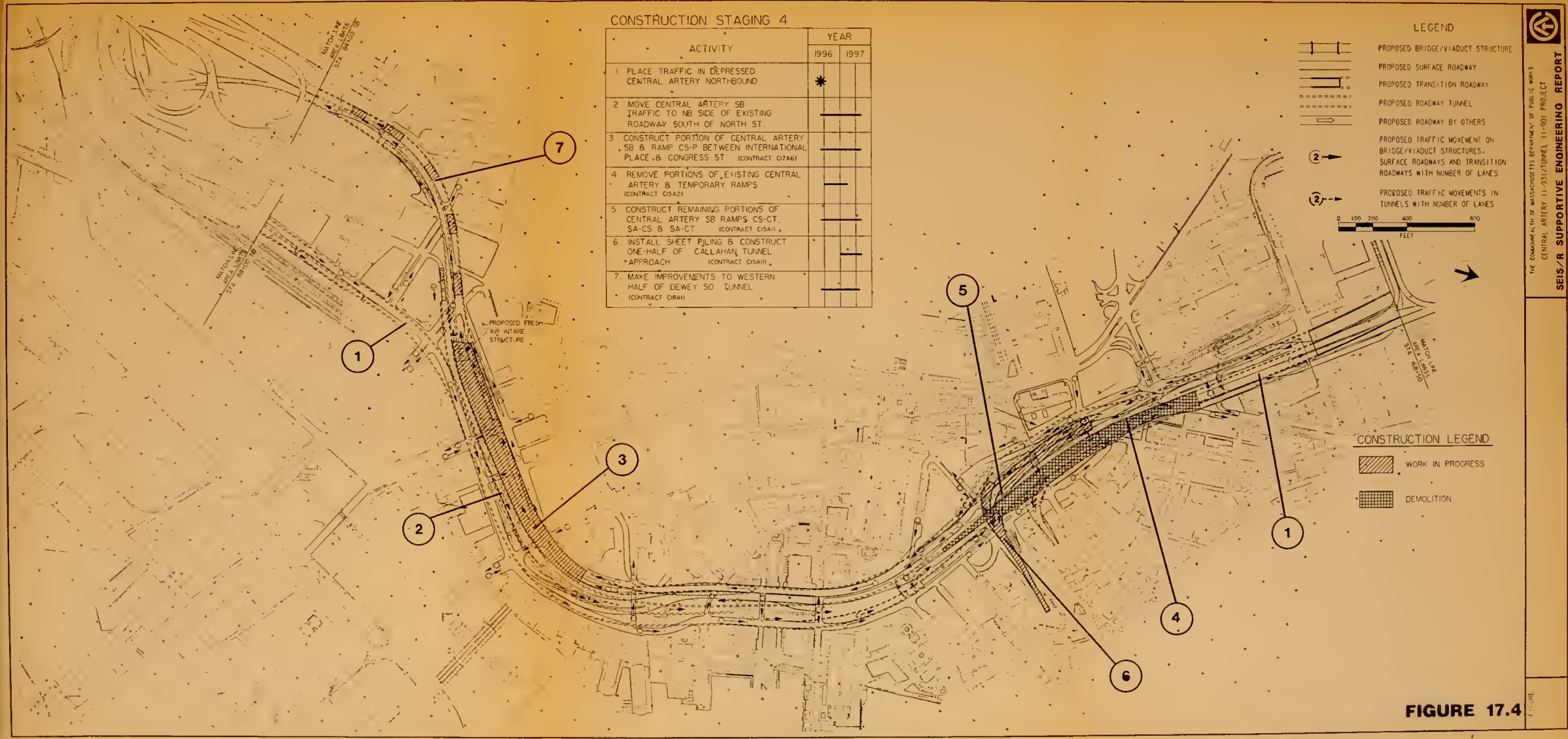
CONSTRUCTION STAGING 4
ACTIVITY
YEAR
1996
1997
1 PLACE TRAFFIC IN DEPRESSED CENTRAL ARTERY NORTHBOUND
2 MOVE CENTRAL ARTERY SB TRAFFIC TO NB SIDE OF EXISTING ROADWAY SOUTH OF NORTH ST.
3 CONSTRUCT PORTION OF CENTRAL ARTERY SB & RAMP CS-P BETWEEN INTERNATIONAL PLACE & CONGRESS ST (CONTRACT C17A6)
4 REMOVE PORTIONS OF EXISTING CENTRAL ARTERY & TEMPORARY RAMPS (CONTRACT C15A2)
5 CONSTRUCT REMAINING PORTIONS OF CENTRAL ARTERY SB RAMPS CS-CT, SA-CS & SA-CT (CONTRACT C15A11)
6. INSTALL SHEET PILING & CONSTRUCT ONE-HALF OF CALLAHAN TUNNEL APPROACH (CONTRACT C15A11)
7. MAKE IMPROVEMENTS TO WESTERN HALF OF DEWEY SQ TUNNEL (CONTRACT C18A11)
LEGEND
PROPOSED BRIDGE/VIADUCT STRUCTURE
PROPOSED SURFACE ROADWAY
PROPOSED TRANSITION ROADWAY
PROPOSED ROADWAY TUNNEL
PROPOSED ROADWAY BY OTHERS
PROPOSED TRAFFIC MOVEMENT ON BRIDGE/VIADUCT STRUCTURES, SURFACE ROADWAYS AND TRANSITION ROADWAYS WITH NUMBER OF LANES
PROPOSED TRAFFIC MOVEMENTS IN TUNNELS WITH NUMBER OF LANES
0 100 200 400 800
FEET
MATCH LINE AREA LIMITS STA 88+00
MATCH LINE AREA LIMITS STA 88+00
PROPOSED FRESH AIR INTAKE STRUCTURE
MATCH LINE AREA LIMITS STA 88+50
CONSTRUCTION LEGEND
WORK IN PROGRESS
DEMOLITION
1
2
3
4
5
6
7

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FIGURE 17.4

CONSTRUCTION STAGING 5
ACTIVITY
YEAR
1997
1998
1. PLACE TRAFFIC IN DEPRESSED CENTRAL ARTERY SB & WESTERN HALF OF DEWEY SQ TUNNEL
2. CONSTRUCT EASTERN HALF OF CENTRAL ARTERY SB AT DEWEY SQ AREA (BETWEEN INTERNATIONAL PLACE & CONGRESS ST (CONTRACT C17A6)
3 CONSTRUCT COUNTERFLOW RAMP R-T (CONTRACTS C17A6 C18A1)
4 MAKE IMPROVEMENT & WIDEN EASTERN HALF OF DEWEY SQ TUNNEL (CONTRACT C18A1)
5 REMOVE TEMPORARY CENTRAL ARTERY SB OFF-RAMPS (CONTRACTS C15A1, C15A2)
6 REMOVE REMAINDER OF EXISTING ELEVATED ARTERY, UNDERPINNING SUPORTS & DECKING (CONTRACTS C15A6, C17A6)
7 COMPLETE TUNNEL BACKFILL & SURFACE RESTORATION WORK (CONTRACTS C15A6, C17A6)
8. COMPLETE RAMP ST-SA (CONTRACT C15A1)
9 OPEN REMAINDER OF DEPRESSED SB CENTRAL ARTERY
10 OPEN REMAINING CENTRAL ARTERY RAMPS INCLUDING RAMPS RT & ST-SA
LEGEND
PROPOSED BRIDGE/VIADUCT STRUCTURE
PROPOSED SURFACE ROADWAY
PROPOSED TRANSITION ROADWAY
PROPOSED ROADWAY TUNNEL
PROPOSED ROADWAY BY OTHERS
PROPOSED TRAFFIC MOVEMENT ON BRIDGE/VIADUCT STRUCTURES, SURFACE ROADWAYS AND TRANSITION ROADWAYS WITH NUMBER OF LANES
PROPOSED TRAFFIC MOVEMENTS IN TUNNELS WITH NUMBER OF LANES
0 100 200 400 800
FEET
MATCH LINE AREA LIMITS STA 88+00
MATCH LINE AREA LIMITS STA 88+00
PROPOSED FRESH AIR INTAKE STRUCTURE
MATCH LINE AREA LIMITS STA 103+50
CONSTRUCTION LEGEND
WORK IN PROGRESS
DEMOLITION
1
2
3
4
5
6
8
9

THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
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SEIS/R SUPPORTIVE ENGINEERING REPORT

FIGURE

FIGURE 17.5

18.0 Preliminary Construction Cost Estimate

The D017A SDC shall be responsible for preparing construction cost estimates as outlined in the Scope of Services in Section 3.2.12 Cost Estimates and Trends.

The approximate construction costs associated with Design Contract D017A and associated Construction Contracts C17A1, C17A2, C17A3 are as follows:

Contract	Description	Cost
C17A1	I-93 Central Artery Northern to Milk	$ 216,086,000
C17A2	I-93 Central Artery Milk to North	$ 169,723,000
C17A3	I-93 Boston Edison Substation Vent Building No. 3	$ 46,105,000
		$ 431,914,000*

*The above costs are direct construction costs and exclude contingency, right-of-way, engineering, construction management, and final surface restoration costs.

Costs shown are based on the 1991 ICE which reflect 4th Quarter 1989 Pricing.

The above costs are based on the scope known for these packages at the time of the preparation of the 1991 ICE.

APPENDIX A
CONSTRUCTION IMPACT MITIGATION

1.0 General

The Massachusetts Department of Public Works requires that the work of the CA/T Project be performed with as little disruption to the public as absolutely necessary.

This document is intended to provide general mitigation requirements to be considered by the Section Design Consultant during the final design effort. Site-specific mitigation requirements are described in the Preliminary Design Report.

The objective of construction impact mitigation is to minimize disruption to:

- Traffic
- Public Transportation
- Vehicular Access
- Pedestrian Access
- Parking

and to minimize the disruption resulting from:

- vibration to adjacent buildings

- noise/air and other environmental concerns

In order to accomplish this objective, the following elements, where applicable, shall be addressed in the construction documents:

- Suggested construction sequencing that would reduce construction impacts.

- Limitation on time of construction operations.

- Available contractor laydown and use areas.

- Contractor access routes.

- Adjacent building access and operational requirements.

- Traffic maintenance requirements.

- Pedestrian access and walkway requirements.

- Localized noise/vibration sensitivities (see CA/T Conservator's Report as referenced in Article 2.7 of this document and the May 1990 draft SEIS).

2.0 Guidelines

2.1 Traffic Maintenance:

The goal during construction is to maintain traffic and transportation service with minimum disruptions to the mobility of the commuting system. The construction document prepared by the SDC shall require the contractor to:

A. Implement the Traffic Management Plan developed by the SDC,

B. Identify and submit detour plans or plans of temporary decking systems to maintain necessary traffic patterns.

C. Clearly sign detours, temporary lane constrictions and closing of roads.

2.2 Transportation Alternatives:

The SDC shall be aware of all transportation alternatives which interface with the design. Many transportation alternatives are under development such as increased MBTA subway, railroad, and bus services.

2.3 Pedestrian Access and Flow:

Safe pedestrian access and flow along streets will be interrupted by construction sites. Safe continuous pedestrian flow along alternate routes must be provided. The SDC shall:

A. Identify pedestrian walkways and pedestrian entrances to buildings that must be maintained during constructions.

B. Design and specify protective walkways and barriers as appropriate to each site and stage. (CA/T design standards and guidelines for walkways and barriers will be provided to the SDC.)

2.4 Vehicular Access:

Vehicular access to loading and delivery areas, pick up and drop off points, and parking facilities will be impacted and may be temporarily interrupted by construction operations. The SDC shall:

A. Identify all locations where vehicular access may be impacted by the work.

B. Obtain data pertinent to the nature of the vehicular access areas such as peak use hours, volume of vehicles, and impact of temporary disruption.

C. Indicate in the construction documents that the contractor shall identify, design, or specify temporary facilities that minimize disruptions.

D. Identify alternate locations for loading zones, delivery and passenger drop-offs, where appropriate.

2.5 Signage & lighting:

Used as a public information tool, signs will convey information on detours, relocated pedestrian ways and altered access to business. The SDC shall:

A. Identify and note in the construction documents clear, visible locations for signs to motorists, pedestrians, rail commuters and building occupants.

B. Design adequate lighting of temporary pathways, roadways and signs for public information and safety.

C. Indicate and specify lighting requirements in the construction documents.

2.6 Parking:

Parking losses will be an unavoidable consequence of construction operations. The SDC shall:

A. Define construction boundaries to minimize disruption to parking.

B. Consider, and where appropriate, specify, methods resulting in the least possible construction impact to existing parking areas.

2.7 Historic Resources:

The SDC shall become familiar with the CA/T Historic Resource Concept Report, December 1988 and any subsequent reports produced by the Conservator for this project and design in accordance with the guidelines and requirements stated.

2.8 Building and Structure Support:

Some buildings or structures in the vicinity of construction are susceptible to effects from the construction operation. These impacts include effects attributable to ground settlement and vibrations. The SDC shall:

A. Refer to the Conservator's Report for the identification of sensitive historic buildings and structures in proximity to the proposed construction area.

B. Conduct structural analyses of any building or structure, as identified in the Preliminary Design Report, likely to be impacted by the construction operation.

C. Specify appropriate building protection methods for the affected structures.

2.9 Construction Method:

Implementation of various construction methods and techniques will have a direct bearing on the impact experienced by surrounding neighborhoods. The SDC shall:

A. Be cognizant of alternative methods for performing the work.

B. Identify locations where particular sensitivities exist and, where conditions warrant, specify suggested methods that reduce impacts.

2.10 Integrated Pest Management:

The SDC shall become familiar with the CA/T Integration Pest Management Program.

2.11 Environmental:

The SDC shall become familiar with the CA/T Environmental Impact Statement and design in accordance with the commitments stated.

2.12 Construction Arts:

A construction arts program will be an integral part of construction activities on this project. A CA/T Arts Administrator will coordinate all arts located activities for the project. Where the locations for construction arts are identified by the Management Consultant, the construction art areas shall be shown in the contract drawings, or indicated in the specifications, (e.g., provision of primed wall barriers to open ground with viewing spots).

Appendix B: Index of Drawings/Preliminary Design Drawings

GENERAL

SHEET NO.	DRAWING NO.	TITLE
1	CA-PD-G-600	TITLE SHEET
2	CA-PD-G-601	INDEX OF DRAWINGS -1-
3	CA-PD-G-602	INDEX OF DRAWINGS -2-
4	CA-PD-G-603	INDEX OF DRAWINGS -3-
5	CA-PD-G-604	INDEX OF DRAWINGS -4-
6	CA-PD-G-619	INDEX OF DRAWINGS -5-
7	CA-PD-G-620	INDEX OF DRAWINGS -6-
8	CA-PD-G-621	INDEX OF DRAWINGS -7-
9	CA-PD-G-653	INDEX OF DRAWINGS -8-
10	CA-PD-G-654	INDEX OF DRAWINGS -9-
11	CA-PD-G-655	INDEX OF DRAWINGS -10-
12	CA-PD-G-656	INDEX OF DRAWINGS -11-
13	CA-PD-G-609	GENERAL NOTES

SURVEY

SHEET NO.	DRAWING NO.	TITLE
14	PW-PD-Y-018	PROJECT SURVEY CONTROL - SHEET 1
15	PW-PD-Y-019	PROJECT SURVEY CONTROL - SHEET 2

CIVIL

SHEET NO.	DRAWING NO.	TITLE
16	CA-PD-C-622	TYPICAL SECTIONS SHEET 1
17	CA-PD-C-623	TYPICAL SECTIONS SHEET 2
18	CA-PD-C-631	TYPICAL SECTIONS SHEET 3
19	CA-PD-C-632	TYPICAL SECTIONS SHEET 4
20	CA-PD-C-625	(NOT USED)
21	CA-PD-C-624	TYPICAL DETAILS - EXIT/ENTRANCE RAMPS
22	CA-PD-C-605	HIGHWAY GEOMETRY PLAN STA.106+70 TO STA.141+00
23	CA-PD-C-607	SURFACE STREET GEOMETRY PLAN STA.206+00 TO STA.241+75
24	CA-PD-C-633	TEMPORARY RAMP R-P GEOMETRY PLAN
25	CA-PD-C-634	TEMPORARY RAMP R-J GEOMETRY PLAN
26	CA-PD-C-610	PROFILE CANB STA.106+70 TO STA.140+80
27	CA-PD-C-611	PROFILE CASB STA.120+00 TO STA.141+00
28	CA-PD-C-612	PROFILE RAMP A-CN
29	CA-PD-C-613	PROFILE RAMP R-T
30	CA-PD-C-614	PROFILE RAMP CS-P
31	CA-PD-C-615	PROFILE RAMP R-R
32	CA-PD-C-616	PROFILE RAMP CS-SA
33	CA-PD-C-617	PROFILE RAMP SA-CS
34	CA-PD-C-618	PROFILE RAMP CN-SA
35	CA-PD-C-635	PROFILE SANB
36	CA-PD-C-636	PROFILE SASB
37	CA-PD-C-637	PROFILE OLIVER ST.

38	CA-PD-C-638	PROFILE PEARL ST.
39	CA-PD-C-639	PROFILE BROAD ST. EAST & WEST
40	CA-PD-C-640	PROFILE HIGH ST.
41	CA-PD-C-641	PROFILE EAST INDIA ROW
42	CA-PD-C-642	PROFILE MILK ST.
43	CA-PD-C-643	PROFILE STATE ST.
44	CA-PD-C-644	PROFILE ATLANTIC AVE.
45	CA-PD-C-645	PROFILE - TEMPORARY RAMP R-P
46	CA-PD-C-646	PROFILE - TEMPORARY RAMP R-J
47	CA-PD-C-626	CRITICAL CROSS SECTION STA.110+27
48	CA-PD-C-627	CRITICAL CROSS SECTION STA.117+67
49	CA-PD-C-628	CRITICAL CROSS SECTION STA.124+97
50	CA-PD-C-629	CRITICAL CROSS SECTION STA.131+06
51	CA-PD-T-647	TRAFFIC MANAGEMENT/CONSTRUCTION STAGING SHEET 1
52	CA-PD-T-648	TRAFFIC MANAGEMENT/CONSTRUCTION STAGING SHEET 2
53	CA-PD-T-649	TRAFFIC MANAGEMENT/CONSTRUCTION STAGING SHEET 3
54	CA-PD-T-650	TRAFFIC MANAGEMENT/CONSTRUCTION STAGING SHEET 4
55	CA-PD-T-651	TRAFFIC MANAGEMENT/CONSTRUCTION STAGING SHEET 5
56	CA-PD-T-652	TRAFFIC MANAGEMENT/CONSTRUCTION STAGING SHEET 6

ARCHITECTURE

SHEET NO.	DRAWING NO.	TITLE
57	AR9-PD-H-100	SURFACE ARCHITECTURAL KEY PLAN
58	AR9-PD-H-101	TUNNEL ARCHITECTURAL KEY PLAN
59	AR9-PD-H-001	PLAN @ RAMP CS-SA & PLAN @ RAMP CN-SA
60	AR9-PD-H-002	PLAN @ RAMP CS-P & PLAN @ RAMP A-CN
61	AR9-PD-H-011	PLAN @ RAMP GORE CS-P & PLAN @ RAMP GORE A-CN/R-T
62	AR9-PD-H-012	PLAN @ RAMP GORE A-CN
63	AR9-PD-H-013	PLAN @ RAMP GORE R-R/CASB
64	AR9-PD-H-022	EGRESS STAIRS STA.125+00 SB
65	AR9-PD-H-023	EGRESS STAIRS STA.116+00 NB
66	AR9-PD-H-024	EGRESS STAIRS STA.131+00 SB
67	AR9-PD-H-026	EGRESS STAIRS STA.140+00 NB
68	AR9-PD-H-027	EGRESS STAIRS STA.140+00 SB
69	AR9-PD-H-020	EGRESS HEADHOUSE STA.125+00
70	AR9-PD-H-028	EGRESS HEADHOUSE STA.131+00
71	AR9-PD-H-060	CROSS SECTION - TUNNEL
72	AR9-PD-H-061	CROSS SECTION - TUNNEL
73	AR9-PD-H-030	TUNNEL WALL ELEVATIONS - MAINLINE
74	AR9-PD-H-031	TUNNEL WALL ELEVATIONS - RAMPS
75	AR9-PD-H-040	TUNNEL CEILING LAYOUT SHEET 1
76	AR9-PD-H-041	TUNNEL CEILING LAYOUT SHEET 2
77	AR9-PD-H-042	TUNNEL CEILING LAYOUT SHEET 3

78	AR9-PD-H-045	TUNNEL CEILING GEOMETRY
79	AR9-PD-H-046	TUNNEL CEILING GEOMETRY KEY PLAN
80	AR9-PD-H-070	CROSS PASSAGE DETAILS
81	AR9-PD-H-071	CROSS PASSAGE DETAILS
82	AR9-PD-H-072	CROSS PASSAGE DETAILS
83	AR9-PD-H-073	CROSS PASSAGE DETAILS
84	AR9-PD-H-090	TUNNEL GRAPHICS PLAN
85	AR9-PD-H-091	TUNNEL GRAPHICS ELEVATIONS
86	AR9-PD-A-001	V.B.#3 SITE PLAN
87	AR9-PD-A-002	V.B.#3 SUBLEVEL 3 PLAN
88	AR9-PD-A-003	V.B.#3 SUBLEVEL 2 PLAN
89	AR9-PD-A-004	V.B.#3 SUBLEVEL 1 PLAN
90	AR9-PD-A-005	V.B.#3 FIRST FLOOR PLAN
91	AR9-PD-A-006	V.B.#3 SECOND FLOOR PLAN
92	AR9-PD-A-007	V.B.#3 ROOF PLAN
93	AR9-PD-A-008	V.B.#3 BUILDING SECTION
94	AR9-PD-A-009	V.B.#3 BUILDING SECTION
95	AR9-PD-A-010	V.B.#3 BUILDING SECTION
96	AR9-PD-A-011	V.B.#3 NORTH ELEVATION
97	AR9-PD-A-012	V.B.#3 EAST ELEVATION
98	AR9-PD-A-013	V.B.#3 SOUTH ELEVATION
99	AR9-PD-A-014	V.B.#3 WEST ELEVATION
100	AR9-PD-A-015	V.B.#3 WALL SECTIONS
101	AR9-PD-A-016	V.B.#3 WALL SECTIONS & DETAILS
102	AR9-PD-A-017	V.B.#3 ENLARGED ELEVATION
103	AR9-PD-A-028	V.B.#3 NORTH ELEVATION - GUIDELINES
104	AR9-PD-A-029	V.B.#3 EAST ELEVATION - GUIDELINES
105	AR9-PD-A-030	V.B.#3 SOUTH ELEVATION - GUIDELINES
106	AR9-PD-A-031	V.B.#3 WEST ELEVATION - GUIDELINES
107	AR9-PD-L-001	EXISTING CONDITIONS CONGRESS ST. TO OLIVER ST. (INCLUDES V.B.#3)
108	AR9-PD-L-002	EXISTING CONDITIONS OLIVER ST. TO HIGH ST.
109	AR9-PD-L-003	EXISTING CONDITIONS HIGH ST. TO CENTRAL ST.
110	AR9-PD-L-004	EXISTING CONDITIONS CENTRAL ST. TO CLINTON ST.
111	AR9-PD-L-005	EXISTING CONDITIONS CLINTON ST. TO NORTH ST.
112	AR9-PD-L-011	CONSTRUCTION MITIGATION - CONGRESS ST. TO OLIVER ST.
113	AR9-PD-L-012	CONSTRUCTION MITIGATION - OLIVER ST. TO HIGH ST.
114	AR9-PD-L-013	CONSTRUCTION MITIGATION - HIGH ST. TO CENTRAL ST.
115	AR9-PD-L-014	CONSTRUCTION MITIGATION - CENTRAL ST. TO CLINTON ST.
116	AR9-PD-L-015	CONSTRUCTION MITIGATION - CLINTON ST. TO NORTH ST.
117	AR9-PD-L-031	SITE IMPROVEMENTS - CONGRESS ST. TO OLIVER ST. WEST
118	AR9-PD-L-032	SITE IMPROVEMENTS - OLIVER ST. TO HIGH ST.

119	AR9-PD-L-033	SITE IMPROVEMENTS - HIGH ST. TO CENTRAL ST.
120	AR9-PD-L-034	SITE IMPROVEMENTS - CENTRAL ST. TO CLINTON ST.
121	AR9-PD-L-035	SITE IMPROVEMENTS - CLINTON ST. TO NORTH ST.
122	AR9-PD-L-041	V.B.#3 LANDSCAPING PLAN

RIGHT OF WAY

SHEET NO.	DRAWING NO.	TITLE
123	PW-PD-R-193	D017A TITLE AND INDEX
124	PW-PD-R-194	D017A TYPICAL SECTION SHEET
125	PW-PD-R-195	D017A TYPICAL SECTION SHEET
126	PW-PD-R-196	D017A TYPICAL SECTION SHEET
127	PW-PD-R-197	D017A TYPICAL SECTION SHEET
128	PW-PD-R-198	D017A CA NORTH TO CONGRESS PARCEL SUMMARY SHEET
129	PW-PD-R-199	D017A CA NORTH TO CONGRESS - LOCATION PLAN
130	PW-PD-R-200	D017A CA NORTH TO CONGRESS 40 SCALE PROPERTY PLAN

UTILITIES

SHEET NO.	DRAWING NO.	TITLE
131	PW-PD-U-332	COMPOSITE UTILITIES RELOCATIONS - ROLL PLAN
132	PW-PD-U-341	WATER - ROLL PLAN
133	PW-PD-U-339	WASTEWATER - ROLL PLAN
134	PW-PD-U-349	ELECTRICAL - ROLL PLAN
135	PW-PD-U-351	TELEPHONE - ROLL PLAN
136	PW-PD-U-352	GAS - ROLL PLAN
137	PW-PD-U-353	STEAM - ROLL PLAN
138	PW-PD-U-330	EXISTING MINOR UTILITIES - ROLL PLAN
139	PW-PD-U-331	SURFACE DRAINAGE - ROLL PLAN
140	PW-PD-U-340	72" NESI RELOCATION ATLANTIC AVENUE PROFILE
141A	PW-PD-U-337A	SURFACE DRAINAGE - ROLL PROFILE
141B	PW-PD-U-337B	SURFACE DRAINAGE - ROLL PROFILE
142	PW-PD-U-354	CANB STA. 106+80 SECTION
143	PW-PD-U-355	CANB STA. 198+16 SECTION
144	PW-PD-U-333	CANB/BASELINE - SECTIONS
145	PW-PD-U-334	CANB/BASELINE - SECTIONS
146	PW-PD-U-335	72" NESI/BASELINE - SECTIONS
147	PW-PD-U-336	72" NESI/BASELINE - SECTIONS
148	PW-PD-U-342	S.D. PUMPING STATION @ CS-SA - DETAILS
149	PW-PD-U-343	S.D. PUMPING STATION @ CN-SA - DETAILS
150	PW-PD-U-344	S.D. PUMPING STATION @ A-CN & CS-P - DETAILS
151	PW-PD-U-345	FINAL BACKFILL - DETAILS
152	PW-PD-U-346	STEAMLINE - DETAILS
153	PW-PD-U-347	TEMPORARY SUPPORTS - DETAILS

154	PW-PD-U-348	UTILITIES CORRIDORS - DETAILS

TRAFFIC

SHEET NO.	DRAWING NO.	TITLE
155	TR1-PD-T-001	TRAFFIC CONTROL LEGEND.
156	TR1-PD-T-002	TRAFFIC VOLUMES I-93 NB/SB MAINLINE ROADWAY
157	TR1-PD-T-003	TRAFFIC VOLUMES SURFACE STREETS
158	TR1-PD-T-004	TRAFFIC AND TRANSPORTATION DRAWING KEY PLAN
159	TR1-PD-T-005	TRAFFIC CONTROL - INTERSECTION OF CONGRESS STREET AT ATLANTIC AVENUE AND PURCHASE STREET
160	TR1-PD-T-006	TRAFFIC CONTROL: ATLANTIC AVENUE BETWEEN CONGRESS STREET AND PEARL STREET
161	TR1-PD-T-007	TRAFFIC CONTROL: ATLANTIC AVENUE BETWEEN PEARL STREET NORTHERN AVENUE
162	TR1-PD-T-008	TRAFFIC CONTROL: INTERSECTION OF NORTHERN AVENUE AT ATLANTIC AVENUE
163	TR1-PD-T-009	TRAFFIC CONTROL: ATLANTIC AVENUE BETWEEN NORTHERN AVENUE AND HIGH STREET
164	TR1-PD-T-010	TRAFFIC CONTROL: INTERSECTION OF HIGH STREET AND BROAD STREET AT ATLANTIC AVENUE AND PURCHASE STREET
165	TR1-PD-T-011	TRAFFIC CONTROL: INTERSECTION OF INDIA ROW AT ATLANTIC AVENUE AND PURCHASE STREET
166	TR1-PD-T-012	TRAFFIC CONTROL: INTERSECTION OF MILK STREET AT ATLANTIC AVENUE AND SURFACE ARTERY (SB)
167	TR1-PD-T-013	TRAFFIC CONTROL: INTERSECTION OF STATE STREET AT ATLANTIC AVENUE AND SURFACE ARTERY (SB)
168	TR1-PD-T-014	TRAFFIC CONTROL: INTERSECTION OF ATLANTIC AVENUE AT CROSS STREET AND SURFACE ARTERY (SB)
169	TR1-PD-T-015	TRAFFIC CONTROL: CROSS STREET AND SURFACE ARTERY (SB) BETWEEN CROSS STREET AND NORTH STREET

STRUCTURE DESIGN DATA SHEETS (TUNNELS)

GENERAL

SHEET NO.	DRAWING NO.	TITLE
170	CA-PD-S-855	LOCATION PLAN
171	CA-PD-S-856	KEY PLAN
172	CA-PD-S-857	INDEX SHEET 1

STRUCTURAL

SHEET NO.	DRAWING NO.	TITLE

173	CA-PD-S-861	PLAN STA.106+70 TO STA.141+00
174	CA-PD-S-862	CANB PROFILE STA.106+70 TO STA.141+00
175	CA-PD-S-863	CASB PROFILE STA.120+00 TO STA.141+00
176	CA-PD-S-864	RAMP CS-SA PROFILE
177	CA-PD-S-865	RAMP CN-SA PROFILE
178	CA-PD-S-866	RAMP A-CN PROFILE
179	CA-PD-S-867	RAMP R-T PROFILE
180	CA-PD-S-868	RAMP CS-P PROFILE
181	CA-PD-S-869	RAMP R-R PROFILE
182	CA-PD-S-870	RAMP SA-CS PROFILE
183	CA-PD-S-877	CROSS SECTION A
184	CA-PD-S-878	CROSS SECTION B
185	CA-PD-S-879	CROSS SECTION C
186	CA-PD-S-880	CROSS SECTION D
187	CA-PD-S-881	CROSS SECTION E
188	CA-PD-S-882	CROSS SECTION F
189	CA-PD-S-883	CROSS SECTION G
190	CA-PD-S-884	CROSS SECTION H
191	CA-PD-S-885	CROSS SECTION I
192	CA-PD-S-886	CROSS SECTION J
193	CA-PD-S-887	CROSS SECTION K
194	CA-PD-S-888	CROSS SECTION L
195	CA-PD-S-889	CROSS SECTION M
196	CA-PD-S-890	CROSS SECTION N
197	CA-PD-S-891	CROSS SECTION 0
198	CA-PD-S-892	CROSS SECTION P
199	CA-PD-S-893	CROSS SECTION Q
200	CA-PD-S-894	CROSS SECTION R
201	CA-PD-S-895	CROSS SECTION S
202	CA-PD-S-896	CROSS SECTION T
203	CA-PD-S-897	CROSS SECTION U
204	CA-PD-S-898	CROSS SECTION V
205	CA-PD-S-899	CROSS SECTION W
206	CA-PD-S-900	CROSS SECTION X
207	CA-PD-S-901	CROSS SECTION Y
208	CA-PD-S-902	CROSS SECTION Z
209	CA-PD-S-903	CROSS SECTION AA
210	CA-PD-S-904	CROSS SECTION BB
211	CA-PD-S-905	CROSS SECTION CC
212	CA-PD-S-906	CROSS SECTION DD
213	CA-PD-S-907	CROSS SECTION EE
214	CA-PD-S-908	CROSS SECTION FF
215	CA-PD-S-909	CROSS SECTION GG
216	CA-PD-S-910	CROSS SECTION HH
217	CA-PD-S-911	CROSS SECTION II
218	CA-PD-S-912	CROSS SECTION JJ
219	CA-PD-S-913	CROSS SECTION KK
220	CA-PD-S-914	CROSS SECTION LL
221	CA-PD-S-915	CROSS SECTION MM
222	CA-PD-S-916	CROSS SECTION NN
223	CA-PD-S-917	CROSS SECTION OO
224	CA-PD-S-918	CROSS SECTION PP
225	CA-PD-S-919	CROSS SECTION QQ

226	CA-PD-S-920	DIMENSION SHEET
227	CA-PD-S-921	SECTION AND DETAILS
228	CA-PD-S-922	SECTION AND DETAILS
229	CA-PD-S-923	CROSS PASSAGE - DETAILS
230	CA-PD-S-924	CROSS PASSAGE - DETAILS
231	CA-PD-S-925	CROSS PASSAGE - DETAILS
232	CA-PD-S-926	EMERGENCY EGRESS/ACCESS DETAILS
233	CA-PD-S-927	EMERGENCY EGRESS/ACCESS DETAILS
234	CA-PD-S-928	EMERGENCY EGRESS/ACCESS DETAILS
235	CA-PD-S-929	EMERGENCY EGRESS/ACCESS DETAILS
236	CA-PD-S-930	EMERGENCY EGRESS/ACCESS DETAILS

GEOTECHNICAL

SHEET NO.	DRAWING NO.	TITLE
237	PW-PD-K-081	BORING LOCATION PLAN 1
238	PW-PD-K-082	BORING LOCATION PLAN 2
239	PW-PD-K-083	SUBSURFACE PROFILE W WALL 1
240	PW-PD-K-084	SUBSURFACE PROFILE W WALL 2
241	PW-PD-K-085	SUBSURFACE PROFILE E WALL 1
242	PW-PD-K-086	SUBSURFACE PROFILE E WALL 2

STRUCTURE DESIGN DATA SHEETS (VENT BUILDING #3)

GENERAL

SHEET NO.	DRAWING NO.	TITLE
243	CA-PD-S-680	LOCATION PLAN
244	CA-PD-S-681	SITE LOCATION PLAN
245	CA-PD-S-682	INDEX OF DRAWINGS & NOTES

STRUCTURAL

SHEET NO.	DRAWING NO.	TITLE
246	CA-PD-S-683	LOGITUDINAL AND TRANSVERSE FOUNDATION SECTIONS
247	CA-PD-S-684	SUBGRADE 3 LAYOUT PLAN
248	CA-PD-S-685	SUBGRADE 2 LAYOUT PLAN
249	CA-PD-S-686	SUBGRADE 1 LAYOUT PLAN
250	CA-PD-S-687	GROUND FLOOR PLAN
251	CA-PD-S-688	2ND FLOOR PLAN
252	CA-PD-S-689	ROOF PLAN
253	CA-PD-S-690	EXHAUST STACKS PLAN
254	CA-PD-S-691	SUBGRADE LEVEL STRUCTURAL FRAMING SYSTEM
255	CA-PD-S-692	ABOVE GRADE LEVEL STRUCTURAL FRAMING SYSTEM
256	CA-PD-S-693	SUPPLY DUCTS ROUTING PLAN
257	CA-PD-S-694	EXHAUST DUCTS ROUTING PLAN
258	CA-PD-S-695	DUCT ROUTING: SUPPLY & EXHAUST - ZONE 1
259	CA-PD-S-696	DUCT ROUTING: SUPPLY & EXHAUST - ZONE 2
260	CA-PD-S-697	DUCT ROUTING: SUPPLY & EXHAUST - ZONE 3
261	CA-PD-S-698	STRUCTURAL LONGITUDINAL SECTION

262	CA-PD-S-699	STRUCTURAL LONGITUDINAL SECTION
263	CA-PD-S-700	STRUCTURAL TRAVERSE SECTION
264	CA-PD-S-701	EXISTING UTILITY & SITE PLAN
265	CA-PD-S-702	LONGITUDINAL SECTION THRU EXISTING & PROPOSED SUBSTRUCTURES
266	CA-PD-S-703	SUPPLY DUCT CONNECTIONS
267	CA-PD-S-704	EXHAUST DUCT CONNECTIONS
268	CA-PD-S-705	EXHAUST DUCT CONNECTIONS DETAILS

GEOTECHNICAL

SHEET NO.	DRAWING NO.	TITLE
269	PW-PD-K-041	BORING LOCATION PLAN
270	PW-PD-K-042	GEOTECHNICAL PROFILES: SECTIONS A-A & B-B
271	PW-PD-K-043	GEOTECHNICAL PROFILES: SECTIONS C-C & D-D

STRUCTURE DESIGN DATA SHEETS (UNDERPINNING & TEMPORARY RAMPS)

GENERAL

SHEET NO.	DRAWING NO.	TITLE
272	CA-PD-S-720	TITLE SHEET/LOCATION PLAN
273	CA-PD-S-721	KEY PLAN
274	CA-PD-S-722	DRAWING LIST A
275	CA-PD-S-723	DRAWING LIST B
276	CA-PD-S-724	GENERAL NOTES

STRUCTURAL

SHEET NO.	DRAWING NO.	TITLE
277	CA-PD-S-725	GENERAL PLAN 1
278	CA-PD-S-726	GENERAL PLAN 2
279	CA-PD-S-727	GENERAL PLAN 3
280	CA-PD-S-728	BENT 34 - PLAN/ELEVATION
281	CA-PD-S-729	BENT 34 - DETAILS
282	CA-PD-S-730	BENT 35 - PLAN/ELEVATION
283	CA-PD-S-731	BENT 35 - DETAILS
284	CA-PD-S-732	BENTS RI1-36 - PLAN/ELEVATION
285	CA-PD-S-733	BENTS RI1-36 - DETAILS
286	CA-PD-S-734	BENTS 37-RJ1 - PLAN/ELEVATION
287	CA-PD-S-735	BENTS 37-RJ1 - DETAILS
288	CA-PD-S-736	BENT 38 - PLAN/ELEVATION
289	CA-PD-S-737	BENT 38 - DETAILS
290	CA-PD-S-738	BENT 39 - PLAN/ELEVATION
291	CA-PD-S-739	BENT 39 - DETAILS
292	CA-PD-S-740	BENT 40 - PLAN/ELEVATION
293	CA-PD-S-741	BENT 40 - DETAILS
294	CA-PD-S-742	BENT 41 - PLAN/ELEVATION
295	CA-PD-S-743	BENT 41 - DETAILS
296	CA-PD-S-744	BENT 42 - PLAN/ELEVATION
297	CA-PD-S-745	BENT 42 - DETAILS
298	CA-PD-S-746	BENT 43 - PLAN/ELEVATION
299	CA-PD-S-747	BENT 43 - DETAILS
300	CA-PD-S-748	BENT 44 - PLAN/ELEVATION

301	CA-PD-S-749	BENT 44 - DETAILS
302	CA-PD-S-750	BENT 45 - PLAN/ELEVATION
303	CA-PD-S-751	BENT 45 - DETAILS
304	CA-PD-S-752	BENT 48 - PLAN/ELEVATION
305	CA-PD-S-753	BENT 48 - DETAILS
306	CA-PD-S-754	BENT 49 - PLAN/ELEVATION
307	CA-PD-S-755	BENT 49 - DETAILS
308	CA-PD-S-756	BENT 50 - PLAN/ELEVATION
309	CA-PD-S-757	BENT 50 - DETAILS
310	CA-PD-S-758	BENT 51 - PLAN/ELEVATION
311	CA-PD-S-759	BENT 51 - DETAILS
312	CA-PD-S-760	BENT 52 - PLAN/ELEVATION
313	CA-PD-S-761	BENT 52 - DETAILS
314	CA-PD-S-762	BENT 53 - PLAN/ELEVATION
315	CA-PD-S-763	BENT 53 - DETAILS
316	CA-PD-S-764	BENT 54 - PLAN/ELEVATION
317	CA-PD-S-765	BENT 54 - DETAILS
318	CA-PD-S-766	BENT 55 - PLAN/ELEVATION
319	CA-PD-S-767	BENT 55 - DETAILS
320	CA-PD-S-768	BENT 56 - PLAN/ELEVATION
321	CA-PD-S-769	BENT 56 - DETAILS
322	CA-PD-S-770	BENT 57 - PLAN/ELEVATION
323	CA-PD-S-771	BENT 57 - DETAILS
324	CA-PD-S-772	BENT 58 - PLAN/ELEVATION
325	CA-PD-S-773	BENT 58 - DETAILS
326	CA-PD-S-774	BENT 59 - PLAN/ELEVATION
327	CA-PD-S-775	BENT 59 - DETAILS
328	CA-PD-S-776	BENT 60 - PLAN/ELEVATION
329	CA-PD-S-777	BENT 60 - DETAILS
330	CA-PD-S-778	BENTS 61-RM1 - PLAN/ELEVATION
331	CA-PD-S-779	BENTS 61-RM1 - DETAILS
332	CA-PD-S-780	UNDERPINNING TEMPORARY RAMP TYPICAL ELEVATION
333	CA-PD-S-781	UNDERPINNING TEMPORARY RAMP DETAILS
334	CA-PD-S-782	DECKING GENERAL PLAN 1
335	CA-PD-S-783	DECKING GENERAL PLAN 2
336	CA-PD-S-784	DECKING GENERAL PLAN 3
337	CA-PD-S-785	DECKING FRAMING PLAN 1
338	CA-PD-S-786	DECKING FRAMING PLAN 2
339	CA-PD-S-787	DECKING FRAMING PLAN 3
340	CA-PD-S-788	DECKING DETAILS
341	CA-PD-S-121	GENERAL PLAN - TEMPORARY RAMP RP
342	CA-PD-S-122	GENERAL PLAN - TEMPORARY RAMP RJ
343	CA-PD-S-123	PROFILE - TEMPORARY RAMP RP
344	CA-PD-S-124	PROFILE - TEMPORARY RAMP RJ
345	CA-PD-S-125	ELEVATION - TEMPORARY RAMP RJ
346	CA-PD-S-126	ELEVATION - TEMPORARY RAMP RP
347	CA-PD-S-127	TYPICAL SECTIONS - TEMP. RAMP SUPERSTRUCTURE
348	CA-PD-S-128	SECTIONS & DETAILS - TEMPORARY RAMPS
349	CA-PD-S-129	TEMPORARY RAMP SECTION RJ
350	CA-PD-S-130	TEMPORARY RAMP SECTION RJ
351	CA-PD-S-131	TEMPORARY RAMP SECTION RP

352	CA-PD-S-132	TEMPORARY RAMP SECTION RP

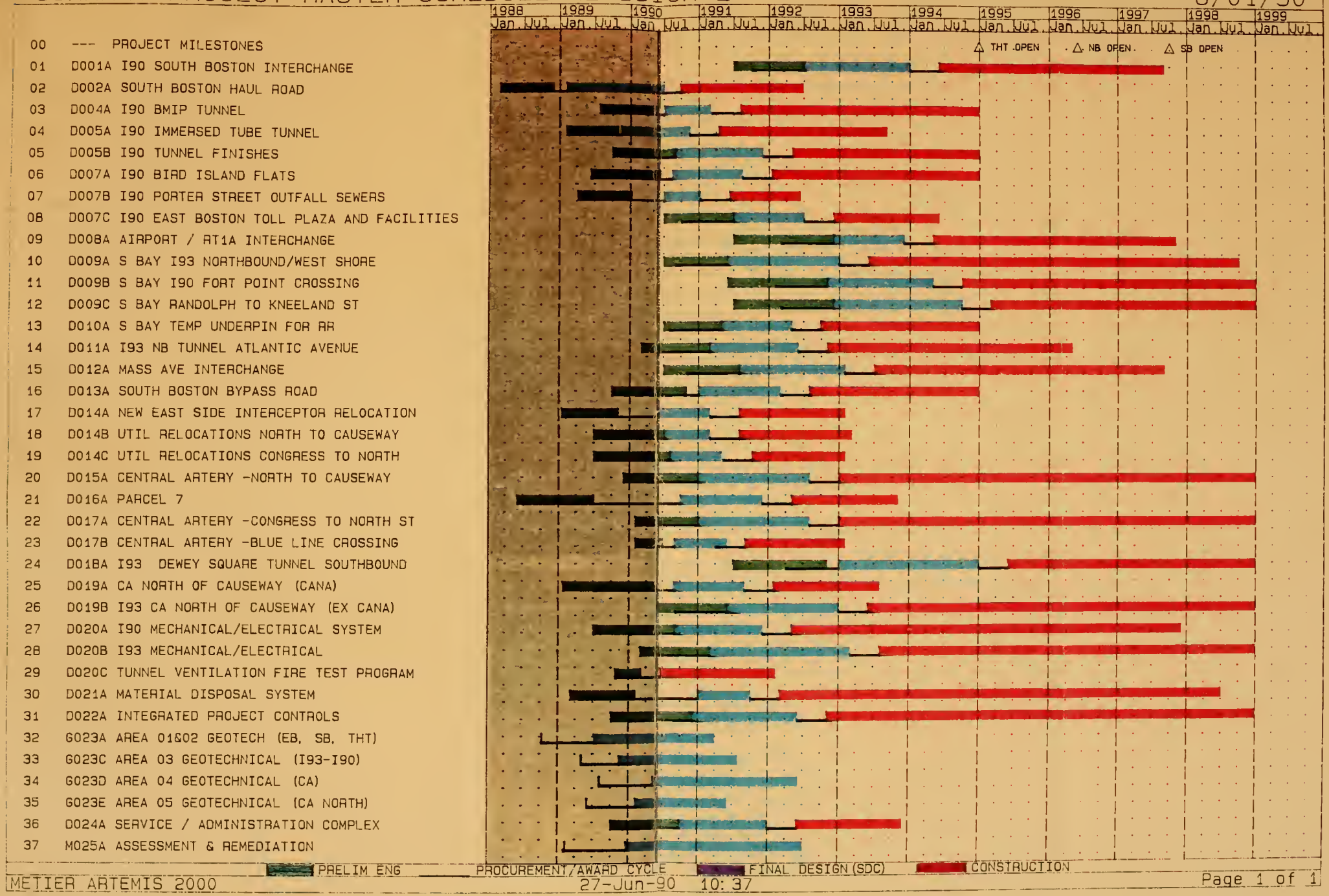
GEOTECHNICAL

SHEET NO.	DRAWING NO.	TITLE
353	PW-PD-K-081	BORING LOCATION PLAN SHEET 1
354	PW-PD-K-082	BORING LOCATION PLAN SHEET 2
355	PW-PD-K-083	GEOTECHNICAL PROFILE WEST SLURRY WALL SHEET 1
356	PW-PD-K-084	GEOTECHNICAL PROFILE WEST SLURRY WALL SHEET 2
357	PW-PD-K-085	GEOTECHNICAL PROFILE EAST SLURRY WALL SHEET 1
358	PW-PD-K-086	GEOTECHNICAL PROFILE EAST SLURRY WALL SHEET 2

CENTRAL ARTERY (I-93) / TUNNEL (I-90) PROJECT

SUMMARY PROJECT MASTER SCHEDULE REVISION 2

6/01/90


1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
Jan Jul
THT OPEN
NB OPEN
SB OPEN
00 --- PROJECT MILESTONES
01 D001A I90 SOUTH BOSTON INTERCHANGE
02 D002A SOUTH BOSTON HAUL ROAD
03 D004A I90 BMIP TUNNEL
04 D005A I90 IMMERSED TUBE TUNNEL
05 D005B I90 TUNNEL FINISHES
06 D007A I90 BIRD ISLAND FLATS
07 D007B I90 PORTER STREET OUTFALL SEWERS
08 D007C I90 EAST BOSTON TOLL PLAZA AND FACILITIES
09 D008A AIRPORT / RT1A INTERCHANGE
10 D009A S BAY I93 NORTHBOUND/WEST SHORE
11 D009B S BAY I90 FORT POINT CROSSING
12 D009C S BAY RANDOLPH TO KNEELAND ST
13 D010A S BAY TEMP UNDERPIN FOR RR
14 D011A I93 NB TUNNEL ATLANTIC AVENUE
15 D012A MASS AVE INTERCHANGE
16 D013A SOUTH BOSTON BYPASS ROAD
17 D014A NEW EAST SIDE INTERCEPTOR RELOCATION
18 D014B UTIL RELOCATIONS NORTH TO CAUSEWAY
19 D014C UTIL RELOCATIONS CONGRESS TO NORTH
20 D015A CENTRAL ARTERY -NORTH TO CAUSEWAY
21 D016A PARCEL 7
22 D017A CENTRAL ARTERY -CONGRESS TO NORTH ST
23 D017B CENTRAL ARTERY -BLUE LINE CROSSING
24 D01BA I93 DEWEY SQUARE TUNNEL SOUTHBOUND
25 D019A CA NORTH OF CAUSEWAY (CANA)
26 D019B I93 CA NORTH OF CAUSEWAY (EX CANA)
27 D020A I90 MECHANICAL/ELECTRICAL SYSTEM
28 D020B I93 MECHANICAL/ELECTRICAL
29 D020C TUNNEL VENTILATION FIRE TEST PROGRAM
30 D021A MATERIAL DISPOSAL SYSTEM
31 D022A INTEGRATED PROJECT CONTROLS
32 G023A AREA 01&02 GEOTECH (EB, SB, THT)
33 G023C AREA 03 GEOTECHNICAL (I93-I90)
34 G023D AREA 04 GEOTECHNICAL (CA)
35 G023E AREA 05 GEOTECHNICAL (CA NORTH)
36 D024A SERVICE / ADMINISTRATION COMPLEX
37 M025A ASSESSMENT & REMEDIATION
PRELIM ENG
PROCUREMENT/AWARD CYCLE
FINAL DESIGN (SDC)
CONSTRUCTION

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